N O T I C E

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(NASA-CR-161482) SOLAR HEATING AND DOMESTIC HOT WATER SYSTEM INSTALLED AT NORTH DALLAS HIGH SCHOOL Final Report (Dallas Independent School District) 106 p HC A06/MF A01 CSCL 10B G3/44

N80-29847

Unclas 28319

DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-161482

SOLAR HEATING AND DOMESTIC HOT WATER SYSTEM INSTALLED AT NORTH DALLAS HIGH SCHOOL - FINAL REPORT

Prepared from documents furnished by

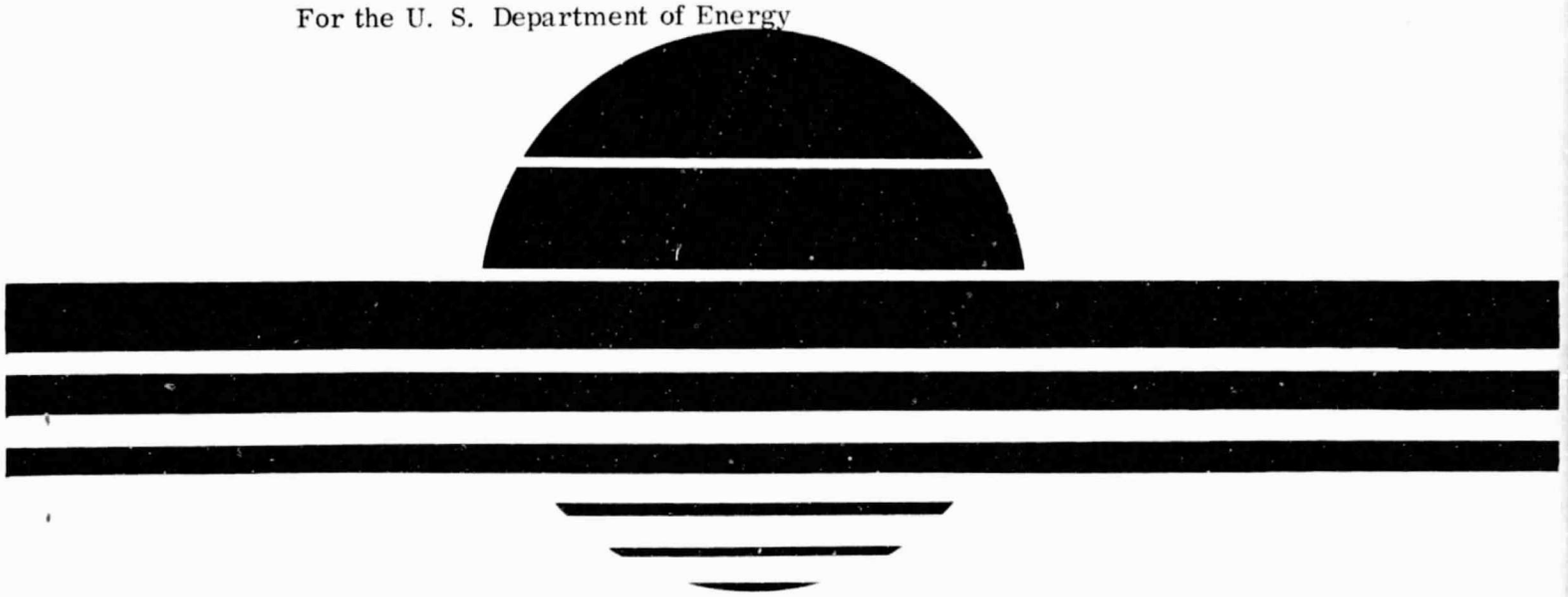
Dallas Independent School District
Office of the General Superinten
3700 Ross Avenue
Dallas, Texas 75204

Under DOE Contract EM-78-F-01-5204

Monitored by

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy



U.S. Department of Energy



Solar Energy

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
DOE/NASA CR-161482		

4. TITLE AND SUBTITLE	5. REPORT DATE
Solar Heating and Domestic Hot Water Systems Installed at North Dallas High School - Final Report	May, 1980
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT #
9. PERFORMING ORGANIZATION NAME AND ADDRESS Dallas Independent School District Office of the General Superintendent 3700 Ross Avenue Dallas, Texas 75204	10. WORK UNIT NO.
	11. CONTRACT OR GRANT NO. EM-78-F-01-5204
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Department of Energy, Conservation and Solar Energy Washington, DC 20585	13. TYPE OF REPORT & PERIOD COVERED Contractor Report - Final
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
This work was done under the technical management of Mr. William A. Hagen, George C. Marshall Space Flight Center, Alabama 35812.

16. ABSTRACT

This Document is the Final Technical Report of the Solar Energy System located at the North Dallas High School, Dallas, Texas. The system is designed as a retrofit in a three story with basement, concrete frame high school building. The building was air conditioned with an electric drive 300-ton chilled water central system in 1973. The building contains 126,000 square feet and the solar energy system will preheat 100 percent of domestic hot water and supply 47.5 percent of annual building heating requirements. During the building cooling seasons, the solar energy system will supply 100 percent of domestic hot water. The solar energy system consists of 4,800 square feet (320 panels) Lennox/Honeywell flat plate liquid collector subsystem, and a 10,000 gallon steel tank storage subsystem circulating hot water producing 686.6 x 10^6 Btu/year (specified) building heating and domestic hot water heating. Architect - Foster & Meir Architects, Inc.; Engineer - W. K. Hall consulting engineer; Contractor - Burden Service Company; with a start up date of December 4, 1979.

This report includes extracts from the site files, specification references for solar modification to existing building heating and domestic hot water systems, drawings, installation, operation and maintenance instructions.

17. KEY WORDS	18. DISTRIBUTION STATEMENT UC59a Unclassified-Unlimited William A. Brooksbank, Jr. WILLIAM A. BROOKSBANK, JR. Mgr., Solar Energy Applications Proj.

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
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Summary

The North Dallas High School Project was selected in part to demonstrate the retrofit of a solar heating and domestic hot water system to a high school built in 1921.

An acceptance test was conducted in December, 1979 and the solar system was declared operational by the site owner in January, 1980. There have been no problems reported, there is insufficient data at this time to determine the percentage of solar contribution.

The retrofit was well planned. The building integrity was not impacted by the roof mounting of collectors or the internal piping from roof to mechanical room.

The roof top is highly visible from the central expressway. The school district is planning a trade course in solar for this high school. Most equipment is readily accessible for class activity.

This site is an example of the multiple benefits available from a demonstration program when properly preplanned.

The National Aeronautics and Space Administration/ Marshall Space Flight Center (NASA/MSFC) provided considerable counsel during the design review and suggested specification changes which permitted greater choice in the selection of a collector manufacturer.

This Final Report is an extraction of various documents from the project working file to give an overview and an insight to this solar energy project.

Project Description

The start-up date for this solar energy system was December 4, 1979, the following document was received, in part, on the reporting activity of this site.

Project Description
Solar Heating and Domestic Hot Water System
North Dallas High School - Dallas, Texas

Abstract

Application - building heating and domestic hot water heating
System Type - circulating hot water
Collector Type - flat plate liquid
Collector Manufacturer - Lennox/Honeywell
Collector Area - 4800 square feet - 320 panels
Storage Capacity - 10,000 gallon steel tank
Building Load (heating plus hot water) - 1424 x 10^6 BTU/yr.
BTU's Produced - 686.6 x 10^6 BTU/yr. (specified)
Building Owner - Dallas Independent School District
Architect - Foster & Meir Architects (renovation)
Engineer - W.K. Hall Consulting Engineer
Contractor - Burden Service Company
Start-Up Date - December 4, 1979

Introduction

This system is designed as a retrofit in a three story with basement, brick masonry, concrete frame high school building. The building is 56 years old but is in excellent structural condition. The building was air-conditioned with an electric drive 300 ton chilled water central system in 1973.

The building contains 126,000 square feet and the solar system will preheat 100% of domestic hot water and supply 47.5% of annual building heating requirements. During the building cooling seasons, the solar system will supply 100% of domestic hot water.

Design Philosophy

The solar system is interconnected with the existing water distribution and air handling systems of the cooling system to convert to a two-pipe heating and cooling system. The existing steam radiation heating system for the building was abandoned but the existing steam boilers are used to supply steam to hot water generators for building stand-by and domestic hot water boost. The Chiller is protected from heating water by a sub-circulation system designed to isolate the chiller completely during the heating mode and furnish gradual tempering of system water during seasonal heating to cooling transition.

Flat plate collectors are utilized based on economic analysis since high temperature water is not required for this application. The existing air-handling units and water coils require only 95°F water to meet the building heating requirements. Existing cooling thermostats were replaced with reverse acting heating-cooling thermostats to control interior conditions and air unit control sequences were modified to meet heating mode requirements.

Collectors are roof mounted since this is the optimum location for this installation. Double deck vertical arrays are used utilizing standard catalog

item steel support structure resting in pitch pans on the flat roof deck. Structure is bolted together.

Operation of the System

1. Solar System - Whenever the temperature at the solar collectors is greater than the temperature in the storage tank, a comparator energizes the solar pump and the collector drain valve closes. The automatic air vents relieve air from the system and a timer keeps the solar pump energized for 3 minutes regardless of the temperature at the collectors. At the end of the 3 minute interval, if the collector temperature is less than the storage tank temperature a comparator de-energizes the solar pump through the timer. However, the timer allows an additional 3 minutes of "on" time before the solar pump is de-activated. Should the collector temperature become greater than the storage temperature during this "off delay cycle" the system reverts back to the "on" cycle as described above. The system drains down only when the outdoor temperature falls below 47°F

When the solar pump is de-energized and outdoor temperature is below 47°F the collector drain valve reverts to its normally open (N.O) position, the motorized vacuum breakers open and allow the collectors and their exposed piping to drain into the solar water storage tank.

2. Space Heating System (solar and stand-by)- Whenever the system is indexed to "winter" through a summer/winter switch, 3-way isolating valves close to the chiller to allow water to bypass the chiller. When flow is established in a flow switch from the solar storage tank the steam valve on the stand-by steam heat hot water generator and the solar system input lines is activated, after the building heating pump is activated.

The steam valve modulates to provide steam to the hot water generator in order to maintain 95°F water supply temperature to the air handling units. When the solar storage tank temperature exceeds 95° the steam valve is full closed, and the steam boiler cycles off.

If the system return water temperature is less than 95°F and less than the solar water storage tank temperature, an auxiliary pump from the storage tank is energized, two storage tank isolating valves open and the main 3-way mixing valve opens to allow preheat of water up to 95°F supply temperature to the stand-by heating hot water generator. When the storage water temperature exceeds 95°, the main system 3-way mixing valve modulates to mix return water and tank water to supply 95° water to the primary building system circulating pump.

Two tight closing isolating valves (100%) open whenever the auxiliary storage tank to system pump is energized and close (fail safe position) whenever this pump is de-energized to prevent complete building system drain down.

3. Space Cooling System - Whenever the system is indexed thru the summer/ winter switch to "summer", a chiller loop circulating pump is activated together with the existing chiller start control sequence, except that the main system 3-way chiller isolating valve remains in the by-pass position, the main 3-way mixing valve from the solar tank to system loop closes to the hot water storage tank and a snap-action valve (NC Valve) opens to form a chilled water tempering loop to temper main building system water temperature down to cooling operating temperatures. Water entering the chiller will never exceed 90° inlet temperature. When main building system water temperature reaches 75°, the isolating 3-way valve and the snap-action valve forming the chiller water tempering loop close and the auxiliary chiller loop will de-activate. System then operates in normal cooling mode.

The cooling coil controls were modified as follows:

(1) Interior zone units utilizing outside air for cooling were modified such that when an aquastat senses a system water temperture greater than 75°F the system will be in the winter position. Whenever the existing space thermostat calls for cooling a 3-way mixing valve closes the coil and the outside air dampers modulate to provide up to 100% outside air for cooling. Whenever the existing space thermostat calls for heating, the above sequence will be reversed. Whenever the aquastat's temperature is below 75°F, the system will operate using chilled water for cooling.

(2) Exterior zone bypass and multi-zone air handling units have aquastats in the entering water lines to the coils which will reverse the action of the space thermostats whenever the aquastats sense supply water temperatures in excess of 75°F.

4. Domestic Water System (solar and supplemental)- Whenever the solar collector temperature comes to operating temperature and domestic hot water storage temperature is below 75°, auxiliary pumps from solar storage and from heat exchanger to hot water storage activate to preheat domestic hot water ahead of the domestic hot water storage tank. A preheat storage tank supplies all make-up water to the domestic hot water storage tank. Whenever the solar water storage tank temperature exceeds 110°, the pump on the preheat tank solar to heat exchanger will be de-energized, a two-way diverting valve will open to main domestic hot water storage tank and an auxiliary pump from solar heat exchanger to main domestic hot water storage tank will activate. When hot water storage tank temperature exceeds 160°, this sequence will reverse.

The existing booster steam heat exchanger for domestic hot water will operate under its own controls as installed, in order to maintain a supply temperature to the building of 120°F minimum.

5. Solar System Safety Features-The "fail safe" drain down system described above will prevent freezing of the collectors.

The solar water storage tank is at atmospheric pressure and therefore, will not support temperatures in excess of 212°F. The solar pump will remain energized in the normal manner described earlier and excess temperature 212°F+ will be vented in the form of steam at the solar water storage tank.

Solar Acceptance Test - January 17, 1980

A Preliminary Final Inspection was conducted on November 30, 1979. The system was cycled. Thermal and electrical readings were recorded and a 'punch list' was developed.

An Acceptance Test was planned for December 11, 1979 with Mr. William A. Hagen, P.E., Government Project Manager. The sun was occluded by a heavy cloud layer; therefore, the sampled readings of November 30th were reviewed with Mr. F. Paul Arnold, Jr. P.E., Director of Engineering Services for the Dallas Independent School District. The equipment was inventoried and cycled.

The Final Acceptance Test was conducted by Mr. Arnold on January 17, 1980. A list of the participating personnel and test results are shown on the following three pages.

NORTH DALLAS HIGH SCHOOL
DALLAS INDEPENDENT SCHOOL DISTRICT

SOLAR TEST - January 17, 1980

The following personnel participated in the test on January 17, 1980:

Mr. Paul Arnold	Dallas Ind. School District
Mr. John Burden	Burden Services
(At Main Solar Panel)	
Mr. Jerry Sams	Burden Service
(At Annular for Solar Water Flow)	
Mr. Jim Sickles	Lennox
Mr. Harry Beimel	Lennox
Mr. Oscar Bradley	Burden Service
(At the Pyranometer)	
Mr. Alan Ladd	Burden Services
Mr. Tommy Burden	Burden Services
Mr. Wade Decker	Burden Services
Mr. Phil Adams	Burden Services
Mr. Ted Jones	Foster-Meier
Mr. Jack Venable	William K. Hall & Co.

D C ACCEPTANCE TEST — DATE: January 17, 1980

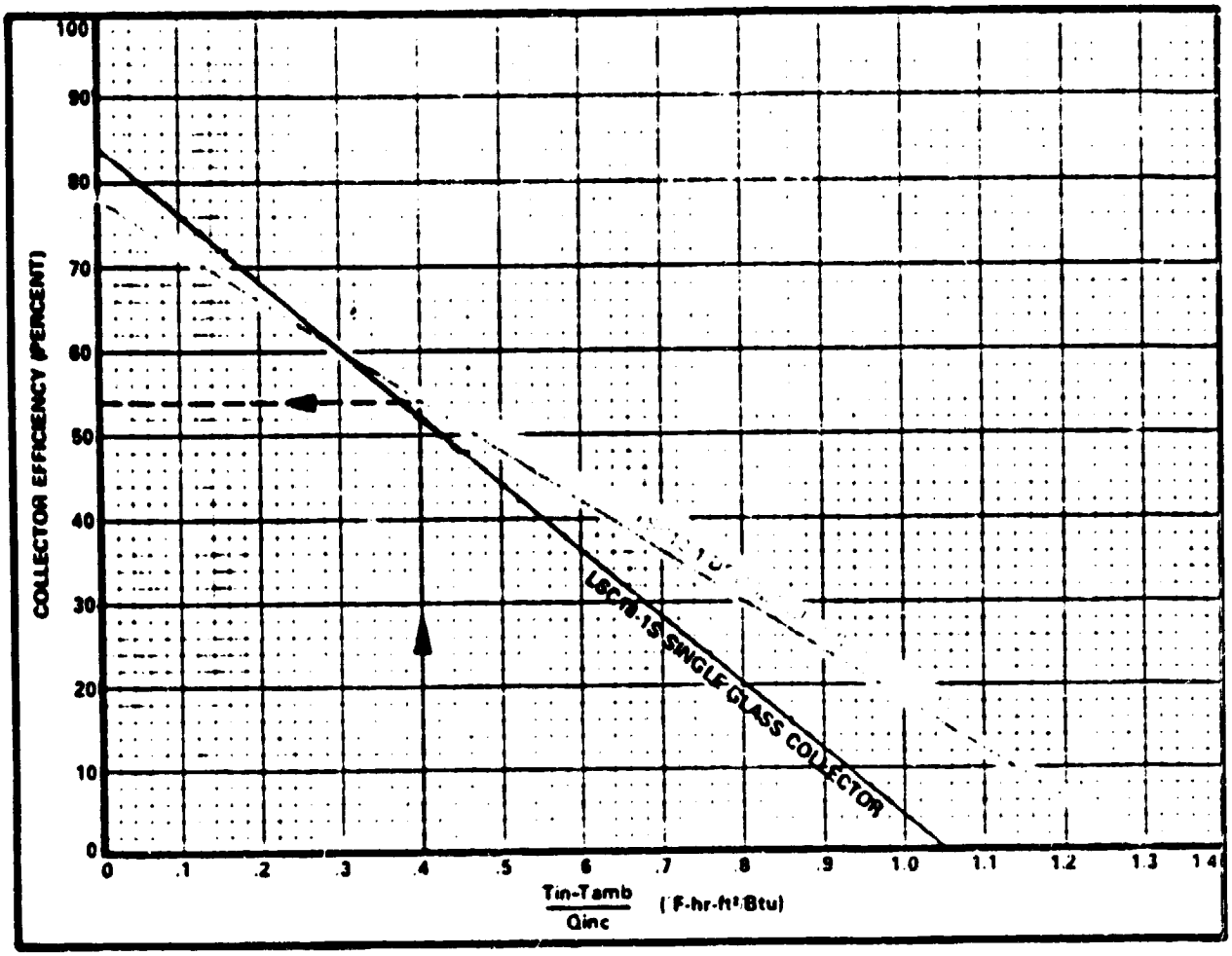
NORTH DALLAS HIGH SCHOOL SOLAR SYSTEM
DALLAS INDEPENDENT SCHOOL DISTRICT

TIME	MAIN SOLAR PANEL S.W.R.	S.W.S.	ΔT	GPM	BTU/ 15 MIN. COLLECTED	SOLAR INSOLATION	TOTAL INSOLATION	CALCULATED EFFICIENCY PER CENT	O.A. D.B. °F.	$\frac{T_1 - T_{AMB.}}{Q}$	LENNOX PUBLISHED EFF.
10:30	141	93	48	89	534,000	256.7	380,040	---	62	0.1013	7[illegible]
10:45	116	94	22	89	244,750	265.8	318,960	76.73	64	0.0940	77
11:00	119	97	22	89	244,750	269.5	323,400	75.68	58	0.1261	74
11:15	121	97	24	95	285,000	293.0	351,600	81.06	61	0.1058	76
11:30	123	99	24	95	285,000	299.0	358,800	79.43	62	0.1070	76
11:45	125	99	26	90	292,500	287.0	344,400	84.93	62	0.1115	75
12:00	129	103	26	95	308,750	309.6	371.520	83.10	60	0.1227	74
12:15	131	105	26	95	308,750	305.0	266,000	84.35	61	0.1279	74
12:30	133	107	26	95	308,750	265.0	318,000	97.09	62	0.1509	72

NOTES:

1. S.W.R. and S.W.S. TEMPERATURE OF WATER TO AND FROM SOLAR PANELS - °F.
2. SOLAR INSOLATION BTU/SQ.FT.
3. TOTAL INSOLATION: BTU FOR 4,800 SQ.FT. OF PANELS FOR 15 MINUTES.
4. SUNRISE AT 7:30, SUNSET AT 5:45
5. SLIGHT HAZE AT 10:45 and 11:15.
6. NO EXPLANATION FOR LOW SOLAR INSOLATION AT 12:30.
7. WIND CONDITIONS: CALM.
8. SYSTEM WAS TURNED ON AT 10:24 A.M.
 10:30 S.W.R. READING HIGH DUE TO STORAGE OF HEAT IN PANELS.

COLLECTOR PERFORMANCE



Tin = Fluid temperature at collector inlet (°F).

Tamb = Ambient temperature surrounding the collector (°F).

Qinc = Incident solar radiation (Btu/hr-ft²).

$$\frac{\text{Fluid Inlet Temperature} - \text{Ambient Temperature}}{\text{Incident Solar Radiation}}$$

ORIGINAL PAGE IS OF POOR QUALITY

EXAMPLE:

To determine the Btu capacity of the collector the fluid inlet temperature, ambient temperature and incident solar radiation (insolation) of the collector must be determined. Assuming an inlet temperature of 110°F and an ambient temperature of 10°F results in 100°F temperature difference. Dividing the temperature difference (100°F) by the incident solar radiation 250Btu hr-ft² equals .40 (see sample calculation). Refer to the collector performance chart and following the example line shown from .40 (bottom scale) to the intersecting point with the collector curve and reading across to the collector efficiency scale read 54% efficiency. Thus 54% of the incident solar value of 250 Btu/hr-ft² results in 135 Btu/hr-ft² output capacity of the collector under the conditions used in this example.

For representative values of Incident Solar Radiation (Q inc) see table below or the 1972 ASHRAE Handbook of Fundamentals, chapter 22, pages 388 thru 392.

SAMPLE CALCULATION:

$$\frac{\text{Tin} - \text{Tamb}}{\text{Qinc}} = \frac{110 - 10}{250} = 0.40$$

Qinc x 0.54 = 135 Btu/hr-ft² Output

ANNUAL MINIMUM AND MAXIMUM DAYS OF SOLAR INCIDENCE (Clear Sky)

SOLAR TIME	24° North Latitude		32 North Latitude		40 North Latitude		48° North Latitude		56 North Latitude	
	INCIDENT SOLAR RADIATION (Q inc) Btu hr-ft²									
	Dec. 21	June 21	Dec. 21	June 21	Dec. 21	June 21	Dec. 21	June 21	Dec. 21	June 21
6 A.M.	---	97	---	130	----	154	----	172	----	185
7 A.M.	69	200	----	209	----	215	----	219	----	221
8 A.M.	225	242	176	244	88	246	----	245	----	243
9 A.M.	281	262	257	263	217	262	140	260	5	256
10 A.M.	304	273	287	273	261	272	214	269	113	264
11 A.M.	314	279	300	278	279	276	242	273	165	268
12 Noon	317	280	304	280	284	278	250	275	180	270
1 P.M.	314	279	300	278	279	276	242	273	165	268
2 P.M.	304	273	287	273	261	272	214	269	113	264
3 P.M.	281	262	257	263	217	262	140	260	5	256
4 P.M.	225	242	176	244	88	246	----	245	----	243
5 P.M.	69	200	----	209	----	215	----	219	----	221
6 P.M.	---	97	---	130	----	154	----	172	----	185

Cooperative Agreement

A Department of Energy cooperative agreement was completed August 31, 1978. This agreement was modified August 17, 1979. The designation of the authorized contracting officer representative was completed October 5, 1978. These three documents are reproduced herein as part of this final report.

Department of Energy

COOPERATIVE AGREEMENT

Pursuant to Authority to PL 93-410, PL 438, PL 473, PL 93-577 and PL 95-91

Page 1 of

1.a. Agreement Number
EM-78-F01-5204

1.b. Modification Number
N/A

2. Agreement Period
From:
To: See Article II

3. Participant Name and Address
Dallas Independent School District
3700 Ross Avenue
Dallas, Texas 75204

4. Participant Type
☐ Educational ☐ Nonprofit
☒ State or Local Government
☐ Profit

5. Project Title
Solar Heating and Hot Water System

6. Reports are required
See Article XIII

7. Participant Project Manager
(Name and Address)
Mr. Francis P. Arnold, Jr.
Dallas Independent School District
3700 Ross Avenue
Dallas, Texas 75204

Telephone No.

8. Government Project Manager
(Name and Address)
Mr. William A. Hagen, FA33
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

Telephone No. (205) 453-2054

9. Method of Payment
See Article IV

10. Accounting and Appropriation Data
WO1-78-8104

89 X 0203.91/CS93/BD-01-01/NFA 609

11. Funding Sources

Source	Amount
DOE	$234,521.
Participant	$ 90,000.
Total Funding	$324,521.

12. Remarks

13. DOE Issuing Office (Name & Address)
D.O.E.
Operations, Division of Procurement
400 First Street, N.W.
Washington, D.C. 20545

14. Amount obligated by this action

$234,521.00

15. DOE Cooperative Agreements Officer

Gary G. Goodwin 8/1/78
(Signature) (Date)

Name (typed) Gary G. Goodwin
Title Agreements Officer
Telephone No. 202 376 9091

CE 31-78

16. Participant Acceptance

By _____ _____
(Signature of Authorized Official) (Date)

Name (typed) Bill C. Hunter
Title President, Board of Education
Telephone No. 824-1620

Attested H. D. Pearson
H. D. Pearson, Secretary
Board of Education

SOLAR COOPERATIVE AGREEMENT NUMBER EM-78-F01-5204

This Agreement, effective _____, 1978, by and between the U.S. Department of Energy (hereinafter called "DOE") and the Dallas Independent School District (hereinafter called "Participant").

WHEREAS, DOE, pursuant to its authority to enter into Cooperative Agreements with non-Federal entities under Sections 7(a)(2) and (8) of P.L. 93-577 and Sections 103(5) and 107(a) of P.L. 93-438 has determined DOE should participate and assist in the project by the Participant and that a Cooperative Agreement for such assistance is appropriate and,

WHEREAS, the Participant, a Local School District under the laws of the State of Texas, has responded to Program Opportunity Notice EG-78-N-01-4200 with a proposed project to provide Solar Heating and Hot Water for a High School Building.

Now Therefore, DOE and the Participant agree as follows:

ARTICLE I - NATURE OF DEMONSTRATION PROJECT ACTIVITY

A. DOE and the Participant agree to undertake and manage on a cooperative basis, in accordance with the terms and conditions specified herein, a demonstration project to install a Solar Heating and Hot Water System at 3120 N. Haskell Avenue, Dallas, Texas.

B. The Participant agrees to provide the necessary land, building, financing, a Solar System and a backup conventional energy system (except as may be otherwise specified herein), and otherwise do all things necessary for or incident to performing the Project as set forth in Appendix A, Statement of Work, which is incorporated herein and made a part hereof.

C. Participant agrees to operate and maintain the Solar System as designed at his own expense throughout the term of this Agreement.

D. Participant agrees to permit DOE personnel or its representatives to monitor the performance of the Solar System for a maximum period of up to five (5) years (demonstration period) after establishment of the Solar System Operational Date.

E. Participant agrees not to alter the design/configuration or identified operational modes of the Solar System throughout the 5 year demonstration period without written approval from the DOE Contracting Officer.

F. Participant agrees to permit Government and Government contracted personnel necessary access to the Participant's and/or major subcontractor's facilities, personnel and records pertaining to the project. This access may include on-site review and inspection functions and participation in project conferences, design reviews, and meetings to the extent necessary to assure the Government Project Manager that the Project Objectives and schedules will be achieved. During on-site inspection and review the Participant shall provide adequate working space for Government and Government contracted personnel to perform their function.

G. The Government, at its option, may provide, at no cost to the Participant an instrumented monitoring system necessary to evaluate the performance of the individual Solar System.

ARTICLE II - TERM OF AGREEMENT

A. The Participant shall perform the work called for under Article I, beginning with the effective date of this Agreement and shall continue for 60 consecutive months from the Solar System Operational Date.

B. The Solar System operational date shall be the date of satisfactory completion of the acceptance tests.

C. The intent of the Government is to evaluate the Solar System for at least one year; however, the Government retains the option of evaluating the Solar System for (1) any continuous period from one year to five years or (2) any combination of noncontinuous periods of six months to three years which occur during the maximum allowed evaluation period of five years.

D. If the Government determines at any time during this five-year period to discontinue evaluation of the Solar System, the Participant shall be so notified by the Contracting Officer and this term of Agreement shall be amended accordingly.

ARTICLE III - ESTIMATED COST, COST SHARING AND DOE COST CEILING

A. The total estimated cost of performing the work under this Agreement is $234,521.00. For the performance of work under this Agreement, the Participant shall be reimbursed by DOE for not more than 72.17 % of the costs of the project determined to be allowable in accordance with the clause of the General Provisions entitled "Allowable Costs and Payment" up to the DOE contribution cost ceiling of $ 233,321. The remaining 27.83 % or more, of the costs of the project so determined shall constitute the Participant's share for which it will not be reimbursed by the Government. It is understood and agreed by the parties of this Agreement that the Participant agrees that he shall complete the work set forth in Appendix A, Statement of Work, without regard to the total actual cost of the project and that the total estimated cost to the Government is hereby established as $234,521., and this amount is also the maximum cost which is subject to reimbursement by the Government.

B. No fee shall be paid the Participant under this cooperative Agreement.

C. The Participant shall maintain current cost information which is in accordance with Clause 13, Appendix B, and which is adequate to reflect the cost of performing the work under this Agreement. Project costs will be considered allowable if they would be allowable under Clause 13, Appendix B.

D. It is also understood and agreed by the parties of this Agreement that the Contracting Officer will withhold $ 1,000.00 to protect the interests of DOE in the receipt of non-instrumented data required after the Solar System Operational Date. It is further agreed that this $ 1,000.00 will be paid upon receipt of the final data report required by Appendix C, item 3.C.(9).

E. The non-technical data is to be collected on Data Collection Forms, Series 10, 20, 30, 40, and 50, as required in Appendix C, paragraph 3.C.(9). The Participant shall complete Series 10, 20 and 50 with assistance, if requested by participant, by the Government or representatives of the Government. Series 30 and 40 shall be accomplished by the Government or representatives of the Government with the cooperation of the Participant. Any other non-instrumented data required by the Government is to be collected by the Government or representatives of the Government during the 5 year demonstration period. Visits to the site for the collection of this data shall be cleared through the Government Contracting Officer prior to each visit. The Participant agrees to provide appropriate key personnel (i.e. Solar or Mechanical Designer, or Project Manager) for each visit and further agrees that funds are provided herein for 6 days not to exceed $25 per hour for a total of $ 1,200.00. This amount is held in reserve for site visits only and shall be billed against each such site visit.

F. The cost sharing arrangement specified in paragraph A. does not apply to the funds reserved for the site visits specified in paragraph E; therefore, the Government will reimburse the Participant 100% of cost up to $1,200.00 for the site visits only. The billing vouchers shall specify "Site visits for collection of data, 100% Government cost".

ARTICLE IV - PAYMENTS

Cost vouchers shall be prepared in accordance with Appendix D, Billing Instructions of this Agreement and submitted as follows:

A. Original and one copy for payment by:

US-DOE
Office of Commercial Accounts, Room C-277
Washington, D. C. 20545

B. Three information copies to:

Project Manager, FA33
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

ARTICLE V - PROJECT MANAGEMENT

A. General - The Participant and the Government will each have an assigned Project Manager for the term of the Agreement between whom it is intended all project matters be coordinated. Additionally, DOE will have assigned a Contracting Officer and the Participant will have assigned a Manager of its Contract Offices to coordinate matters of a contractual nature and to generally assist the Project Managers in effecting complete timely communications and management actions.

B. Project Schedule

The Participant and DOE have agreed to the baseline schedule as set forth in Exhibit 1 of the Statement of Work, entitled "Project Milestones".

Any significant changes in the schedule of Project Milestones will be achieved by mutual cooperation and agreement between the Government and Participant's Project Managers. The agreed changes will be reflected in the Participant's Technical Status Report.

C. Project Reviews

The Participant shall conduct project reviews as set forth in the Statement of Work.

ARTICLE VI - TERMINATION

A. If in the opinion of DOE, the Participant fails to substantially perform under this Agreement, and does not cure such failure within sixty (60) days after written notice of such failure by the Contracting Officer, DOE may by written notice to the Participant by the Contracting Officer terminate this Agreement effective upon receipt of such termination notice by Participant and without liability for the incurrence of any obligations under the Agreement from the date of the receipt of such termination notice. Upon any such termination, the Participant agrees to promptly transfer title to DOE in accordance with ARTICLE VII, Property Title.

B. In the event of disposition of solar system hereunder, DOE will be obligated for no additional costs beyond those provided under the Agreement except for the cost, if any, of packing and transportation of the solar system which would be borne wholly by DOE in the case of termination hereunder.

C. Recognizing the rapid increase in construction costs in the Dallas, Texas, area and recognizing the ceiling cost to DOE, as stated in Article III above, and not withstanding the program completion requirements as stated in said Article III to the contrary, the participant may at any time up to December 26, 1978, elect to withdraw from (terminate) this Cooperative Agreement at no cost to DOE; Participant agreeing to absorb all costs up through withdrawal, if elected, and Participant further agreeing not to invoice to the Government for any payment until after December 26, 1978. Exception to this is cost incurred as stated in Article IX, in the amount of $340.00, which are costs to cover travel as previously agreed upon.

ARTICLE VII - PROPERTY TITLE

All Participant-acquired property procured in support of Appendix "A" Statement of Work shall be the property of the Participant. If for any reason the solar system hardware is not installed because of building construction stoppage, termination or other reason, the Government may claim and receive title to said hardware not to exceed the value of the Government's disbursed cost share.

ARTICLE VIII - GOVERNMENT OPTION TO INSTRUMENT

The Government, at its option, may at anytime between the effective date of this Agreement and six weeks prior to the Final Design Review, elect to install an instrumented data collection system for evaluation of the Solar Systems Performance. Such optional effort shall be subject to equitable adjustment of costs and this Agreement shall be modified accordingly.

ARTICLE IX - DATE OF INCURRENCE OF COSTS

The Participant shall be entitled to reimbursement for domestic travel costs incurred in an amount not to exceed $340.00 on or after July 12, 1978; which, if incurred after this Agreement had been entered into, would have been reimbursable under the provisions of this Agreement.

ARTICLE X - INDEMNIFICATION

The Participant as title holder of the Solar System described herein, is responsible for the design, installation, operation, repair, and maintenance of such system. DOE therefore will not be liable for payment of damages for injuries to any person or loss of life or personal property or loss suffered or sustained and arising from use or operation of the equipment which is a subject of this Agreement. The Participant agrees to indemnify and save the DOE harmless from any and all claims, demands, damages, actions, costs, or charges against the DOE arising as the result of the above mentioned injuries, damages, or loss.

ARTICLE XI - PERMITS

Except as otherwise directed by the Contracting Officer, the Participant shall procure all necessary permits or licenses and abide by all applicable laws, regulations, and ordinances of the United States and of the State, territory, and political subdivision in which the work under this Agreement is performed.

ARTICLE XII - PUBLIC VISIBILITY OF THE SOLAR SYSTEM

The Participant agrees to provide public visibility which will include reasonable physical access to the system, site, and building by the Government and the public consistent with the normal uses of the facilities. The Participant agrees to permit DOE representatives to participate in demonstration and information programs covering the demonstration project, as appropriate. The Government has the option to provide to the Participant a display sign which will be installed by the Participant for public display.

ARTICLE XIII - REPORTING REQUIREMENTS

The Participant shall submit reports in accordance with the instructions of Appendix C of this Agreement.

ARTICLE XIV - ORDER OF PRECEDENCE

In the event of any inconsistency between the provisions of this Agreement the inconsistency shall be resolved by giving precedence in the following order: (a) The Schedule; (b) General Provisions; (c) Other provisions or appendices of the Agreement, whether physically included or incorporated by reference; and (d) Statement of Work including proposal.

ARTICLE XV - COLLECTOR CERTIFICATION

All active solar collectors used in this project must have been tested per ASHRAE 93-77, or equivalent, and a thirty (30) day stagnation test per the Interim Performance Criteria. The test data from these tests shall be supplied to DOE prior to any payments being made to the Participant by DOE.

ARTICLE XVI - CONTENTS OF AGREEMENT

This Agreement consists of the following Articles and Appendices all of which are hereby incorporated in and made a part of this Agreement:

The Schedule of the Agreement

ARTICLE I	- Nature of Demonstration Project Activity
ARTICLE II	- Term of Agreement
ARTICLE III	- Estimated Cost, Cost Sharing, and DOE Cost Ceiling
ARTICLE IV	- Payments
ARTICLE V	- Project Management
ARTICLE VI	- Termination
ARTICLE VII	- Property Title
ARTICLE VIII	- Government Option to Instrument
ARTICLE IX	- Date of Incurrence of Costs
ARTICLE X	- Indemnification
ARTICLE XI	- Permits
ARTICLE XII	- Public Visibility of the Solar System
ARTICLE XIII	- Reporting Requirements
ARTICLE XIV	- Order of Precedence
ARTICLE XV	- Collector Certification
ARTICLE XVI	- Contents of Agreement

APPENDICES:

Appendix A	- Statement of Work
Appendix B	- General Provisions
Appendix C	- Report Requirements
Appendix D	- Billing Instructions

APPENDIX A

STATEMENT OF WORK

I. SCOPE

A. The Dallas Independent School District hereinafter called the Participant, shall provide the necessary skills, services, materials, equipment and facilities to install and conduct an Acceptance Test of a Solar Heating and Hot Water System in a High School Building. This system will be installed in accordance with the designs and specifications set forth in the Participant's technical proposal, submitted in response to Program Opportunity Notice EG-78-N-01-4200. The system will be accepted in accordance with the Acceptance Test Plan required in paragraph II.C. below.

B. The Solar Heating and Hot Water System will meet the performance criteria set forth in Document NBSIR 76-1187, entitled "Interim Performance Criteria for Solar Heating and Cooling Systems in Commercial Buildings" dated November 1976.

C. The technical proposal is hereby incorporated by reference amended as follows: NONE.

1.
2.
3.

D. Following acceptance of the solar system as operational, the Participant shall be responsible for the operation, repair and maintenance of the solar system, and the submittal of applicable data as identified in paragraph II below until expiration of the term of Agreement.

II. DRAWINGS, MANUALS AND PLANS

A. Drawings

1. Design Drawings

The DESIGN DRAWINGS shall be prepared and submitted as required for the final design review. This set of design drawings shall become the baseline drawings to which all subsequent changes are referenced. In general, design CHANGES shall be reflected on this set of design drawings and each revision shall be numbered in sequence. The design drawings shall consist, as a minimum, of the following:

a. SITE PLAN (include on drawing)

1. Building location
2. Structures that will cast shadows on the collectors (either a part of the building or adjacent structures)
3. Major trees that could cast shadows on collectors
4. Equipment-exterior to the building
5. True north arrow
6. Collectors

b. ROOF PLAN OR PLANS (include on drawing)

1. Outline of building
2. Roof slopes or pitches, drains, expansion joints, changes in level, etc.
3. Collectors-located by discussion
4. Collector piping/duct including location and types of valves, expansion capability, anchors, guides, free standing pipe supports, etc.

c. ROOF MECHANICAL PLAN OR PLANS (include on drawings)

1. Locate and note all piping/duct valves/dampers, equipment and controls.

d. ELEVATIONS

1. Building with collector arrays (at least three elevation views, one each, from the south, east and west).

e. DETAILS (include dimensions)

1. Collector support
2. Collector support concepts to roof
3. Collector piping/duct details
4. Piping/duct supports, as part of collector support or free standing, including anchors and guides
5. Storage, building piping/duct entries, and piping details
6. Pipe/duct insulation and waterproofing
7. All mechanical and/or electrical interfaces with conventional system

f. SOLAR SCHEMATIC

1. Indicate equipment and valves/dampers in sufficient detail so as to explain operating modes
2. Operating mode description.

g. CONTROL DESCRIPTION AND SCHEMATIC

1. Description
2. Schematic in sufficient detail to explain all planned operating modes
3. Specifications of major valves and other control components

h. MAJOR COMPONENTS SCHEDULE

1. Pumps, fans, motors
2. Tank(s)
3. Collectors
4. Other

2. As-Built Drawings

a. As-built drawings shall be the design drawings updated to reflect the solar system as it exists at the time of the solar system operational date.

b. Any changes made to the solar system during the operational period shall be incorporated as revisions to the as-built drawings and 5 copies of the revised drawings shall be provided to the Contracting Officer.

B. Operation and Maintenance Manuals

Operation and Maintenance Manuals shall be prepared consistent with standard industry practice. This document shall be written in such a manner as to be easily understood by maintenance personnel who have had no special technical training in solar energy systems. The manual shall be complete. It shall cover the entire solar energy system -- including the collectors, transport system, storage and distribution systems. Particular attention shall be given to controls.

C. Acceptance Test Plan (ATP)

1. The Participant shall develop an ATP which contains the procedure to be followed during acceptance test. A draft version of the plan shall be submitted for review at the Final Design Review. The finalized ATP shall be delivered to the Government Project Manager not later than 14 calendar days prior to the scheduled conduct of the Acceptance Test.

2. The ATP shall include items to be tested, test objectives, test requirements, and test methods.

3. The ATP is to verify:

a. That each item of solar connected equipment (i.e., collectors, storage tanks, controls, fans, pumps, etc.) is installed and operating, as designed, within the manufacturer's specified limits;

b. That the system is balanced to conform as closely as practical to the design performance specifications.

Data collected to verify a. and b. above will be recorded along with the date, time and individual(s) performing test.

III. REVIEWS

The Participant shall conduct the reviews described below at Dallas, Texas. These reviews are to define the specific solar system for installation, acceptance and operation.

The schedule for the reviews is as set forth in Exhibit 1, "Project Milestones".

A. Design Reviews

1. These reviews shall accomplish, but shall not be limited to, the following:

a. Review the solar-related system design to the component level.

b. Review the description and rationale for any solar-related project modifications or deviations which the contractor plans to implement.

c. Review the schedules and costs for the solar portion of the demonstration project.

d. Review the status and content of the drawings, specifications and calculations for the solar portion of the project.

e. Review the status of the Acceptance Test Plan.

2. Five (5) copies of the following documentation shall be delivered to the Government Project Manager fourteen (14) calendar days prior to each scheduled review. In the event that the date for sending this data cannot be met, this fact must be made known to the Government Contracting Officer's Representative not later than 4 weeks prior to final design review. If the fact is known later, the final design review will be rescheduled on a day-for-day basis and the contractor will not hold the Government liable for any additional costs so incurred.

a. Solar system demonstration project schedules.

b. Solar system design drawings (as defined in paragraph II.A.1.).

c. Specifications and other technical data.

d. Solar system Acceptance Test Plan Draft (Final design review only).

EXHIBIT 1 of

APPENDIX A

PROJECT MILESTONES

MILESTONES	DATE
o DESIGN REVIEWS	
• 30% Design Review--in conjunction w/meeting w/City of Dallas	Sept. 6, 1978
• Final (90% complete)	Oct. 23, 1978
o SOLAR SYSTEM SUBCONTRACT'S/AWARDS	
• - Pre Bid Conference	Nov. 22, 1978
• - Sub-Contract award	Dec. 26, 1978
• -	
o DELIVERIES	
• Collectors	TBD
• Other Major Components	TBD
• -	
• -	
• -	
o SOLAR SYSTEM	
• Start Installation	Jan. 10, 1979
• Delivery of Finalized Acceptance Test Plan	TBD
• Complete Installation	May 10, 1979
• Solar System Operational Date	June 11, 1979
o COMPLETE ACCEPTANCE TEST (Solar System Operational Date)	June 14, 1979
o OPEN HOUSE CEREMONIES - (Sometime in September)	TBD
o END OF DEMONSTRATION PERIOD	June 1984

Department of Energy

COOPERATIVE AGREEMENT

Pursuant to Authority to PL 93-410, PL 438, PL 473, PL 93-577 and PL 95-91

1.a. Agreement Number
EM-78-F01-5204

1.b. Modification Number
A001

2. Agreement Period
From:
To: See Article II

3. Participant Name and Address
Dallas Independent School District
3700 Ross Avenue
Dallas, Texas 75204

4. Participant Type
☐ Educational ☐ Nonprofit
☒ State or Local Government
☐ Profit

5. Project Title
Solar Heating & Hot Water System

6. Reports are required
See Article ____

7. Participant Project Manager (Name and Address)
Mr. Francis P. Arnold, Jr.

Telephone No.

8. Government Project Manager (Name and Address)
Mr. William A. Hagen

Telephone No.

9. Method of Payment
See Article IV

10. Accounting and Appropriation Data
89X0210.91
BD01-01-01-CS-90-91
PR#01-79CS35204.001

11. Funding Sources

Source	Amount
DOE	$ 235,241
Participant	$ 90,277
Total Funding	$ 325,518

12. Remarks
See Page 2 for modification description

13. DOE Issuing Office (Name & Address)
D.O.E.
Office of Procurement Operations
400 First Street, N.W.
Washington, D.C. 20545

14. Amount obligated by this action
$ 720.00

15. DOE Cooperative Agreements Officer

ORIGINAL SIGNED
KENNETH D. SOWELL AUG 17 1978
(Signature) (Date)

Name (typed) Kenneth D. Sowell
Title Contracting Officer
Telephone No. (205) 453-0224

16. Participant Acceptance

By _____ _____
(Signature of Authorized Official) (Date)

Name (typed) _____
Title _____
Telephone No. _____

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The purpose of this modification is to provide additional funds for the installation of a double wall heat exchanger and the cooperative agreement is amended as follows:

1. Item 11. Funding Sources on the contract cover page is hereby amended as follows:

Sources	Previous Amount	Increase This Mod.	New Total
DOE	$234,521	$720	$235,241
Participant	90,000	277	90,277
Total Funding	$324,521	$997	$325,518

2. Paragraph A. of ARTICLE III - ESTIMATED COST, COST SHARING AND DOE COST CEILING is hereby amended as follows:

A. The total estimated cost of performing the work is hereby changed from $234,521 to $325,518.

B. The DOE contribution cost ceiling is hereby changed from $233,321 to $234,041.

C. The total estimated cost to the Government is hereby changed from $234,521 to $235,241.

3. APPENDIX A-STATEMENT OF WORK, Paragraph I. C. is amended to delete the word "NONE" and add the following item 1.

"1. A Double Wall Heat Exchanger will be installed in the solar loop for domestic water heating (Participant's bid alternate #6)."

OCT 5 1978

Mr. Francis P. Arnold, Jr.
Dallas Independent School District
3700 Ross Avenue
Dallas, TX 75204

Dear Sir:

DESIGNATION OF AUTHORIZED REPRESENTATIVE FOR THE CONTRACTING OFFICER UNDER COOPERATIVE AGREEMENT NO. EM-78-F01-5204

This is to advise that the Government Project Manager, Mr. William A. Hagen, (George C. Marshall Space Flight Center; Marshall Space Flight Center, Alabama 35812; Code FA33) is the authorized representative of the Contracting Officer for performance of functions as set forth in the attached letter of designation.

Please acknowledge receipt of this advisement in the space provided on the copy of this letter and return to George C. Marshall Space Flight Center; Marshall Space Flight Center, Alabama 35812; Code: AP34.

Sincerely,

ORIGINAL SIGNED BY RONALD D. BACKER

Ronald D. Backer
Contracting Officer

Enclosure

cc:
AP34/OF & RF
FA33/W. A. Hagen
DOE/Conner
DOE/Goodwin

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OCT 5 1978
(Date)

FA33

Systems Demonstration Office

Solar Heating & Cooling Project Office

DESIGNATION OF AUTHORIZED CONTRACTING OFFICER REPRESENTATIVE

REFERENCE: CONTRACT NO. - (COOPERATIVE AGREEMENT) EM-78-F01-5204

CONTRACTOR - (PARTICIPANT) Dallas Independent School District

PROJECT - Solar Heating & Hot Water System

It is necessary for the Government to perform numerous monitoring or administrative activities in its role of assuring the successful accomplishment of contractual requirements. Such activities require the expertise of both technical and business personnel operating in a timely and orderly manner.

Therefore, I hereby designate William A. Hagen **as my duly authorized representative solely for the purpose of performing the administrative functions listed below which may be required in connection with the above reference. However, the representative is** not **authorized to: (a) execute or agree to any changes in the specifications, delivery schedule, or other terms and conditions of the contract; (b) order work outside the scope of the contract; (c) resolve any dispute concerning a question of fact or law arising under the contract; or (d) to further delegate any of the administrative functions listed below unless such redelegation is made in writing and the prior written approval of a duly authorized contracting officer is indicated, in which event a copy of the redelegation shall be made a part of the contract file.**

The authorized representative shall:

1. **Assist the contractor in interpreting technical requirements of the contract's scope of work. (Differences of opinion shall be referred to the contracting officer for resolution.)**

2. **Coordinate with the contractor written technical directions, specifications, and procedures relating to the contractual work requirements.**

FORM ERDA-PO-COAR-977

3. Issue technical directions in accordance with the Technical Direction clause, if any, contained in the contract.

4. Promptly relay information regarding technical problems to the contracting officer.

5. Review and comment on the contractor's request for Government-furnished facilities, supplies, materials, and equipment and forward the request to the contracting officer for disposition.

6. Review and comment on the contractor's request for consent to the purchase of supplies, materials, and equipment, and forward the request to the contracting officer for disposition.

7. Maintain a complete and open line of communication with the contracting officer regarding the contractor's technical performance and progress. When requested provide written assessment of contractor's performance for inclusion in the contractor performance file.

8. Conduct or assure that Government inspection and acceptance are accomplished for:

- ☐ All items, etc.
- ☐ Line items numbers _____
- ☒ Final report
- ☐ None

9. Review payment vouchers and concur with respect to the percent of technical completion for items or services delivered and accepted under the contract.

10. Upon expiration of the contract, provide a written statement attesting to the contractor's completion of technical performance under the contract and of the delivery and acceptance of all goods and services for which inspection and acceptance are herein delegated.

Ronald D. Backer
Contracting Officer

ACKNOWLEDGED:

Authorized Representative

FORM ERDA-PO-COAR-977

Concerns During Implementation

A concern surfaced during site implementation regarding use of a double wall heat exchanger. Contractual language caused doubt for both parties (site owner/DOE). Therefore, the contract was amended for compliance with Section 4.6 (Protection of Potable Water and Circulated Air) of the "Interim Performance Criteria for Solar Heating and Cooling Systems in Commercial Buildings" - NBSIR 76-1187.

A letter from the Dallas Independent School District (November 6, 1978) follows.

dallas independent school district

Rec'd Nov 6

November 6, 1978

Nolan Estes
General Superintendent

Mr. W. A. Hagen, P. E.
Operational Test Site Manager
Solar Heating and Cooling Program, FA33
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Dear Mr. Hagen:

Per your request of October 3, 1978 concerning chemical treatment in Dallas Independent School District steam boilers, we are happy to furnish the following information.

1. The only chemical which is transported into the steam lines by vaporization and entrained with the steam to the heat exchangers is cyclo-hexylamine in a concentration not exceeding 10 PPM. This same chemical in the same concentration is approved by health authorities for steam cleaning of dairy equipment, according to our water treatment contractor.

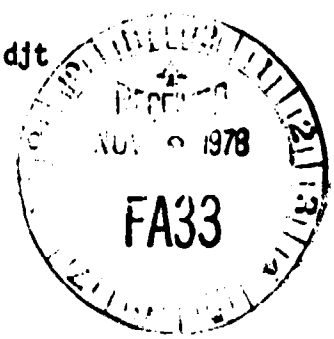
2. The Dallas Independent School District uses this treatment in 289 steam heating boilers, many of which also serve steam heat exchangers to domestic hot water systems. Many of these systems exceed 20 years of service, with no cross contamination problems.

We trust that this is the information you requested.

Sincerely,

F. P. Arnold, P. E.
Chief Engineer

FPA:djt



3700 Ross Avenue, Dallas, Texas 75204, 214/824-1620

At DOE/MSFC request, the project was bid with alternate #6 being the purchase and installation of a double wall heat exchanger.

After much dialogue the agreement was modified (Mod A001 dated August 17, 1979) by both Statement of Work and a shared cost. The action is reproduced on pages 26 and 27 of this Final Report.

Recommend of Award of Contract to Install

The report of the Recommend of Award of Contract to Install Solar Heating and Hot Water System at North Dallas High School follows.

FOR USE BY BUSINESS OFFICE ONLY

APPROVED _____ FILED _____

BOARD FILE NO. _____

BOARD OF EDUCATION
DALLAS INDEPENDENT SCHOOL DISTRICT

DALLAS, TEXAS December 12, 1978

TITLE OF DOCUMENT: RECOMMEND AWARD OF CONTRACT TO INSTALL SOLAR HEATING AND HOT WATER SYSTEM AT NORTH DALLAS HIGH SCHOOL

(USE CAPS)

Sealed bids for the installation of a solar heating and hot water system at North Dallas High School in accordance with plans and specifications prepared by Foster-Meier Architects were received and opened at 3:00 p.m., Friday, December 1, 1978.

The Administration recommends award of the contract to Burden Service Company on their low bid as follows:

Base Bid	$295,260.00
Alternate No. 2 (Gym Heating)	20,915.00
Alternate No. 3 (Roof Walks)	3,410.00
Alternate No. 4 (New Roof)	40,520.00
TOTAL CONTRACT PRICE	$360,105.00

This project is funded partially by a Federal cost sharing agreement based on a proposal submitted by the District in January, 1978, based on cost estimates prepared in December, 1977. The ceiling on the Federal funds is $233,321.00 of actual solar costs, allocated on a participation of 72.17% of project costs up to $323,293.00. The balance of all costs over the Federal ceiling are to be borne by the District from the Operating Fund.

The Administration further recommends that the President and Secretary of the Board be authorized to execute this contract prior to December 26, 1978, in order to meet the terms of the contract between the District and the U. S. Department of Energy.

Cost sharing is to be as stated above.

RECOMMENDED:

GENERAL SUPERINTENDENT

SCHOOL ATTORNEY | [illegible] | ASSISTANT SUPERINTENDENT | ASSOCIATE SUPERINTENDENT

Assoc. Superintendent

APPROVED: _____ COMMITTEE

CHAIRMAN

FOR USE BY BUSINESS OFFICE ONLY

APPROVED _____ FILED _____

BOARD FILE NO. _____

BOARD OF EDUCATION
DALLAS INDEPENDENT SCHOOL DISTRICT

DALLAS, TEXAS December 12, 1978

TITLE OF DOCUMENT: RECOMMEND PURCHASE OF SECTIONALIZED SOLAR WATER STORAGE TANK AND SUPPORTS FOR NORTH DALLAS HIGH SCHOOL SOLAR SYSTEM

(USE CAPS)

Separate sealed bids for furnishing components of the solar water storage tank and its mounting supports for the North Dallas High School Solar Heating System were received and opened at 3:00 p.m., Friday, December 1, 1978.

The Administration recommends immediate purchase of these items from Ashcraft Company, Inc., on their low bid of $5,440.00. Costs will be shared 72.17 percent from Federal Funds with the balance from the Operating Fund.

RECOMMENDED:

GENERAL SUPERINTENDENT

SCHOOL ATTORNEY | [redacted] | ASSISTANT SUPERINTENDENT | ASSOCIATE SUPERINTENDENT

Assoc. Superintendent

APPROVED: _____ COMMITTEE

CHAIRMAN

Final Design Review

The Final Design Review was held October 26, 1978. This report originated by PRC Energy Analysis Company follows.

PRC Energy Analysis Company

prc

March 12, 1979

PMK 3/15/79

Mr. Bill Hagen
NASA/MSFC
Solar Heating & Cooling Program
FA-33
Huntsville, Alabama 35812

Dear Mr. Hagen:

Enclosed are our comments generated from our Final Design Review meeting for the North Dallas High School.

The comments are provided to act as a reminder of significant items discussed at the Final Design Review meeting.

Sincerely,

James L. Easterly

James L. Easterly
Senior Associate

JLE:lj

Enclosure

Final Design Review Report

C100.01.02.32

cc: Mr. Carl Conner
Mr. Russell O'Connell (w/o enclosure)
Mr. Thomas Canning (w/o enclosure)
PRC/EAC Contracts

A Planning Research Company
7600 Old Springhouse Road, McLean, Virginia 22102
Telephone (703) 893-1822

SOLAR HEATING & COOLING DEMONSTRATION
PROJECT REVIEW COMMENTS

PROJECT I.D. EG-78-N-01-4200 #5204 PAGE 1 OF 6

PROJECT TITLE: North Dallas High School, Dallas, Texas

COMMENT SHEET ORIGINATOR & ORGANIZATION Jim Easterly, PRC Energy Analysis Company DATE

PROJECT MANAGER & ORGANIZATION William Hagen, DOE/MSFC

TYPE OF REVIEW PDR ☐ FDR ☒

DOC. REF.	COMMENTS	ACTION TAKEN
	Attendees of final design review held October 26, 1978. William A. Hagen - NASA - MSFC - (DOE) John Borzoni - Honeywell, ERC Robert T. George - William K. Hall & Co. F. P. Arnold - DISD Dayton Forbes - Foster & Meier Architects, Inc. James Easterly - PRC Energy Analysis Co. Stephen Weinstein - The Ehrenkrantz Group Frank L. Meier - Foster & Meier Architects, Inc.	

CLOSE OUT: PARTICIPANT DATE GOV'T PROJECT MANAGER DATE GOV'T SUPPORT CONTRACTOR

SOLAR HEATING & COOLING DEMONSTRATION
PROJECT REVIEW COMMENTS

PROJECT I.D. EG-78-N-01-4200 #5204 PAGE 2 OF 5

PROJECT TITLE: North Dallas High School, Dallas, Texas

COMMENT SHEET ORIGINATOR & ORGANIZATION Jim Easterly, PRC Energy Analysis Company DATE

PROJECT MANAGER & ORGANIZATION William Hagen, DOE/NASA-MSFC

TYPE OF REVIEW PDR ☐ FDR ☒

DOC. REF.	COMMENTS	ACTION TAKEN
Building	1. The long roof curbs will undoubtedly cause puddling on the roof. Check to see that roofing material will withstand standing water without deterioration.	
General	1. How is "swing" type weather handled with a two-pipe heating/ cooling system (i.e., when heating may be needed in the morning and cooling in the afternoon)?	The system as is will not allo heating and cooling in the sam day.
Collectors	1. If selective and non-selective absorber coatings are acceptable under the specification, it would be good to state what approach "sol cost" etc. should be used for determining energy contribution. 2. The specifications allow for many different absorber materials but only one collector enclosure construction. The latter might be made less restrictive. 3. How is inter-collector and manifold tubing insulated?	
Structure	1. Due to the different slopes encountered by each curb beam, the collector support will require a significant amount of shimming. Detail #4 and #5 should acknowledge this requirement and provide a solution. Realize that at times the front or rear of the support will require shimming.	

CLOSE OUT: PARTICIPANT DATE GOV'T PROJECT MANAGER DATE GOV'T SUPPORT CONTRACTOR

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SOLAR HEATING & COOLING DEMONSTRATION
PROJECT REVIEW COMMENTS

PROJECT I.D. EG-78-N-01-4200 #5204 PAGE 3 OF

PROJECT TITLE: North Dallas High School, Dallas, Texas

COMMENT SHEET ORIGINATOR & ORGANIZATION Jim Easterly, PRC Energy Analysis Company DATE

PROJECT MANAGER & ORGANIZATION William Hagen, DOE/NASA-MSFC

TYPE OF REVIEW PDR ☐ FDR ☒

DOC. REF.	COMMENTS	ACTION TAKEN
Structure (continued)	2. Rolled steel angle construction could very possibly be a less expensive approach to construction of the collector support. This alternative should be covered in the specification, also the paint requirement for the steel.	
	3. The long pitch pocket could be a problem due to the unsupported length of each side. The use of intermediate brace pieces should be considered.	
	4. The area of pitch in the pitch pockets seems excessive. A 5" or 6" wide pocket would be less expensive and possibly more stable.	
	5. Continuous 70'± steel beams open to the sun could shear their anchors due to temperature movement. If the beams were installed in shorter sections it would simplify the installation and allow for better drainage.	
	6. Diagonal wind bracing should be provided in the support structure	
	7. Check the draindown piping space requirements to insure that there is sufficient space on the support and that the farthest array is high enough above the roof to allow sufficient roof-supported pipe pitch.	
	8. A walking surface roof protection should be provided.	Will do.

CLOSE OUT: PARTICIPANT DATE GOV'T PROJECT MANAGER DATE GOV'T SUPPORT CONTRACTOR

SOLAR HEATING & COOLING DEMONSTRATION
PROJECT REVIEW COMMENTS

PROJECT I.D. EG-78-N-01-4200 #5204 PAGE 4 OF 5

PROJECT TITLE: North Dallas High School, Dallas, Texas

COMMENT SHEET ORIGINATOR & ORGANIZATION Jim Easterly, PRC Energy Analysis Company DATE

PROJECT MANAGER & ORGANIZATION William Hagen, DOE/NASA-MSFC

TYPE OF REVIEW PDR ☐ FDR ☒

DOC. REF.	COMMENTS	ACTION TAKEN
Transport	1. Consider a low-water alarm rather than an automatic water make-up.	
	2. The upper and lower pipe configuration might be simplified by using an offset and an "S" bend rather than a "U" bend.	
	3. Can molded fiberglass be made to match the interconnecting piping between collectors? Consider UV protected armaflex.	
	4. Flow balancing may be quite difficult as the system now exists. Could some of the piping be run indoors? Has a reverse return system been evaluated?	
	5. Can the functions of pumps P-1, P-2 and/or P-3 be combined to possibly eliminate one or two of the pumps?	Will reconsider the function of P-3 and attempt to eliminate P-1.
	6. Problems may arise with vapor rising into the outdoor piping, condensing and then freezing.	Will consider.
	7. The minimum slope of the manifold piping should be shown for proper drain-down. Are there any valve restrictions?	
	8. Pump flow restriction may not be a problem; consequently, valve (V-7) may not be necessary.	
	9. Solar distribution headers should be switched to feed the supply at the top and draw return from the bottom of the tank.	

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CLOSE OUT: PARTICIPANT DATE GOV'T PROJECT MANAGER DATE GOV'T SUPPORT CONTRACTOR

SOLAR HEATING & COOLING DEMONSTRATION
PROJECT REVIEW COMMENTS

PROJECT I.D. EG-78-N-01-4200 #5204 PAGE 5 OF 5

PROJECT TITLE: North Dallas High School, Dallas, Texas

COMMENT SHEET ORIGINATOR & ORGANIZATION Jim Easterly, PRC Energy Analysis Company DATE

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TYPE OF REVIEW PDR ☐ FDR ☒

DOC. REF.	COMMENTS	ACTION TAKEN
Storage	1. Tank supports should be insulated, with a thermal break between the support and slab.	
	2. A sight glass should be added to the storage tank.	
Control	1. According to the DHW specs, temperature sensor (T-7) activates pump (P-6), however the line on which T-7 is attached will not have flow until P-6 is on.	Will locate T-7 in DHW tank.
	2. Consider a maximum temperature setting for collector temperature sensor (T-3) to prevent pump (P-3) from starting should collectors be over this setting.	Will consider
	3. Pump (P-4) should be turned on with the collectors at some "incremental" temperature setting above storage.	Will do.
	4. What is the control mode for valve (V-9)?	Valve (V-9) is controlled by motorized vacuum breaker and set to close with V-7.

CLOSE OUT: PARTICIPANT DATE GOV'T PROJECT MANAGER DATE GOV'T SUPPORT CONTRACTOR

Project Status Reports

Five Project Status Reports and one supplemental were received during site solar system implementation. These are included in the following pages.

dallas independent school district

March 6, 1979

Linus Wright
General Superintendent

Mr. W. A. Hagen
Project Manager, FA33
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Re: North Dallas High School
Solar Project
Report No. 1

Dear Bill:

The status of the North Dallas High School Project is as follows:

1. The installing contractor, Burden Service Company is set up on the job doing mostly preliminary checking and measuring of the building.

2. The supply and return heating water lines are run from the solar storage tank room to the point where they will join the existing main system lines.

3. The sectionalized solar storage tank is in place and is approximately 50 percent complete.

4. Contractor's shop drawings are being reviewed by the design engineer.

5. The contractor has been authorized by the DISD to supply the double wall heat exchanger for the solar domestic hot water heat exchanger.

6. The project is progressing satisfactorily at this stage.

3700 Ross Avenue, Dallas, Texas 75204, 214/824-1620

We are also attaching our first progress payment request covering basic design fees, the solar storage tank (which was bid separately, as you will recall) and the contractor's first payment request. Also attached is the cost breakdown as required in the DOE contract.

Should you have any questions, please advise.

Sincerely,

F. P. Arnold, P. E.
Chief Engineer

FPA:djt
Attachments

dallas independent school district

DMKJ 5/8/79 Rec'd 5/11/79

May 8, 1979

Linus Wright
General Superintendent

Mr. W. A. Hagen
Project Manager, FA 33
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Re: North Dallas High School
Solar Project
Report No. 2

Dear Bill:

The status of the North Dallas High School Project is as follows:

1. The solar storage tank fabrication is completed and the tank filled with water for leak testing and to fit it snugly into the support cradles. It will be drained, dried, sandblasted internally and externally, then epoxy coated inside and urethane insulated externally after all piping connections are made.

2. Piping risers to attic are complete and ready for insulation.

3. Piping to Gym areas is complete and waiting for installation of fan-coil units.

4. Electrical work has been started in equipment room area.

5. Solar collectors have been delivered to jobsite and are stored in two completely enclosed and locked 40 ft. truck trailers.

6. Weather has delayed start of roof work, which has prevented any solar work on roof. Roofer is on the job as of May 7 and estimates two weeks work to install new roofing and set all required pitch pans for solar supports, pipe penetrations, etc.

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7. Roof piping will be re-routed to remove north-south collector array mains from roof to attic area below to achieve optimum fall as well as added protection of inside location from physical damage to insulation and U.V. degradation. Single supply and return risers from each of the array run-outs along the array support structure will penetrate the roof to the array north-south mains in the attic on each side of the building. Adequate swing joints and expansion loops will be provided for thermal expansion and contraction. It is our opinion that this is a design improvement from an operating and maintenance viewpoint and we request your early approval of this change.

Attached is our second progress payment request covering technical site support fees and contractor payments for the period February through April. Obligated funds have increased $997.00 to reflect the cost of the double wall H.E. shown as Change #1 on the Contractor's pay request No. 3, attached. We request additional DOE participation to cover this increased project cost.

Should you have any questions, please advise.

Sincerely,

F. P. Arnold, P. E.
Chief Engineer

FPA:djt
Attachments

dallas independent school district

6/4/79

June 4, 1979

Linus Wright
General Superintendent

Mr. W. A. Hagen
Project Manager, FA 33
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Re: N. Dallas High School Solar Project
Report No. 3

Dear Bill:

The North Dallas High School project is not moving at the expected rate because of heavy rains during the month of May which stopped the roof work. Hopefully the rains have stopped and the roof work will continue so that the collector installation can be started.

The Contractor is also reporting difficulty in getting Doucette to deliver the double-wall heat exchanger for domestic hot water preheat, which has been on order for 90 days.

The general status is as follows:

1. Piping of the solar water mains in the attic is well under way .
2. Pumps, domestic hot water preheat tank have been delivered.
3. Repair of wooden roof support structure is well under way.
4. Electrical and control work has been minimal.

The contractor has requested a 90 day extension of time which we have not approved. Our estimate is that the project will be 45 to 60 days past the June 11 operational date.

Per our phone conversation, we request that you review the payment request of Voucher No. 2, copy attached, which covered travel expenses to San Diego. As you can see DOE cost shared this expense, which is not in our Agreement. Voucher No. 1, covering Atlanta expenses, is in our Agreement, Article IX, in the amount of $340.00 to be reimbursed, yet the DOE cost shared this expense also. We request that both these payments be corrected to the amounts claimed, since the travel was only because of Government request.

3700 Ross Avenue, Dallas, Texas 75204, 214/824-1620

Also attached for your approval is Voucher No. 5 covering all costs to May 25, 1979.

Should you have any questions, please advise.

Sincerely,

F. P. Arnold, P.E.
Chief Engineer

FPA:djt
Attachments - Copies Vouchers 1 & 2
Voucher 5 and Documentation



dallas independent school district

August 24, 1979

Linus Wright
General Superintendent

Rcvd 8/31

Mr. W. A. Hagen, P. E.
Project Manager, FA 33
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Re: North Dallas High School
Solar Project
Report No. 4

Dear Bill:

The North Dallas High School Project is still not progressing at the rate that it should and I have advised the Contractor that although we are allowing the payment request for July, which is part of the attachment, we will accept no additional requests until the system is operational to the extent that hydronic flow balancing work in the arrays and solar piping system can be commenced.

The general status is as follows:

1. Piping of solar mains in attic is complete.
2. Solar equipment room piping is 80 percent complete.
3. Epoxy coating of storage tank interior complete.
4. Storage tank exterior ready for urethane application.
5. Roof array support structure being assembled.
6. First complete array scheduled to be complete 8-31-79.
7. Domestic water heating system in place complete.
8. All new roofing is in the "Dry", ready for pitch pans, finish coat, walkways, etc.
9. Electrical work 70 percent complete.

The Contractor estimates late September for a trial run on the acceptance test. I will attempt to give you a call once a reasonable date is established should you care to be here to observe the preliminary test runs.

As you can see, I am back on the job, although on half-days until September 3. Paul Dyer will still be my eyes as far as work on the roof is concerned for a little while longer.

3700 Ross Avenue, Dallas, Texas 75204, 214/824-1620

Attached for your approval is Voucher No. 6, covering all costs through July 26, 1979 and reflecting modification A001 for the double-wall heat exchanger.

Should you have any questions, please advise.

Sincerely,

F. P. Arnold, P. E.
Chief Engineer

FPA:djt
Attachments

cc: Mr. Paul D. Dyer, P. E.

dallas independent school district

November 13, 1979

Linus Wright
General Superintendent

Mr. W. A. Hagen
Project Manager, FA 33
George C. Marshall Space Flight Center
Marshall Space Flight Center, Ala. 35812

Re: N. Dallas High School
Solar Project Report No. 5

Dear Bill:

The North Dallas High School Project is 97 per cent complete and is manually operational. All work on the roof is complete except for insulating the small piping from array manifolds to solar panels and final control connections to mechanical vents on each array and master sequencing sensor connections. The main equipment room control panel and sub-panel also are incomplete. The controls sub-contractor states the systems will be functional by November 16 but will need another week for de-bugging.

As reported by phone to you, we will tentatively schedule the acceptance test for the first week in December, weather permitting, in order to meet your travel schedule. We will re-confirm with the weather service the preceding week.

Attached is our Pay Request No. 7 which will over-run the cumulative Cooperative Agreement amount. We have shown a parenthetical adjustment to reflect this situation.

Should you have any questions, please advise.

Sincerely yours,

F. P. Arnold, P. E.
Chief Engineer

FPA:ota

3700 Ross Avenue, Dallas, Texas 75204, 214/824-1620

PmKd 11/9/79

Solar Heating and Domestic Hot Water System

North Dallas High School - Dallas, Texas

F. P. Arnold, Jr., P. E.

Oscar Bradley

Application - building heating and domestic hot water heating
System Type - circulating hot water
Collector Type - flat plate liquid
Collector Manufacturer - Lennox
Collector Area - 4800 square feet
Storage Capacity - 10,000 gallon steel tank
Building Load (heating plus hot water) - 1424 x 10^6 BTU/yr.
BTU'S Produced - 686.6 x 10^6 BTU/yr. (specified)
Building Owner - Dallas Independent School District
Architect - Foster & Meier Architects (renovation)
Engineer - W. K. Hall Consulting Engineers
Contractor - Burden Service Company

Introduction

This report is intended to be a supplement to the project report as submitted in the San Diego 1978 Contractor's Review. The project was out for bids for installation at that time, therefore that report covered system design only.

This up-date deals only with system installation. Unforeseen long term delays due to widespread winter weather damage and later heavy and prolonged rains set planned completion back 120 days. Acceptance tests are planned to commence November 15, 1979, sunshine permitting.

Installation

The following comments result from observation by the Contractor as well as by the Project Manager during the construction of this project. Several basic occurrences in this phase are noteworthy because of their unusual nature.

The storage tank originally consisted of three options:

1. Buried insulated steel; outside building line.

2. Utilization of an existing abandoned indoor swimming pool, capped and insulated, or

3. Steel tank inside the building.

The Owner opted to use the third method. However, entry was limited because the only means of access to the basement area selected as the installation site was through either an abandoned air shaft approximately 5' x 12' extending through the roof, or a horizontal pipe tunnel approximately 6' x 6'.

The tank, 8' diameter by 27' length, was moved through the tunnel in pre-formed and pre-rolled sections and assembled by welding in place, then insulated with 3" polyurethane and internally lined with epoxy paint. The installation was accomplished in this manner with a minimum of disruption to the school. Footings supporting the tank cradles extend below the existing basement floor. Double thicknesses of load bearing neoprene pads are used as thermal barriers between the steel tank and the steel tank cradles. This prevents heat loss to the ground. Total filled tank weight is 50 tons.

To minimize the danger of traffic damage and freezing to piping on the roof, the solar water distributing mains to the solar arrays were moved to an attic location rather than the roof. This has worked very well, although slightly complicating the installation.

A Change Order involving requirement of a double-walled heat exchanger in the domestic hot water preheat system created some delay in the project due to poor delivery performance and also, some problems with space requirements and insulation. These were due to the configuration of the heat exchanger, i.e., narrow, long, and with exposed annular vented tubes.

Water make-up to the storage system was originally planned to be via a float valve with a low water alarm. Since the system inherently could possibly be over-filled, this was changed during construction to a manual make-up with both high and low water alarms and a 30" sight glass was installed.

The solar panel support structure, after careful planning, was installed with a minimum of problems, and proved to be very substantial. This is a bolted structure fabricated from proprietary formed steel shapes, factory finished. The flat plate panels which are mounted at 45° accommodated very readily to this type structure. Each array consists of panels arranged in a double stack with the upper and lower panel piped in series. The pair is fed from the array supply manifold and discharges into the array return manifold back to the solar storage tank. Array distribution piping manifolds as well as the supply and return horizontal mains located in the five foot high attic below were carefully graded to obtain maximum drainage within the limits of installation conditions, since this is a drain-down system.

Project Status

At the time of this writing, the system controls require some work for automatic operation. The system has been pressure tested and operated manually for brief periods and during one four hour period on a clear sunny day with outdoor ambient temperature averaging 80°F, raised 8000 gallons of storage water from 65°F to 130°F temperature. This was under no-load conditions, however.It is anticipated that the system will go on-line November 19, 1979.

Solar Use of Facilities

A request was received by the Dallas Independent School District for use of the school facilities for solar energy related activity. This correspondence follows:

RECEIVED
APR 21 1980

dallas independent school district

Linus Wright
General Superintendent

April 17, 1980

Mr. John H. Carlson
Texas Energy and Natural
Resources Advisory Council
411 West 13th Street
Austin, Texas 78701

Dear Mr. Carlson:

Thank you for your letter of April 4, 1980 concerning the use of school facilities.

The Dallas Independent School District is pleased to accommodate the Texas Energy and Natural Resources Advisory Council at the North Dallas High School on Thursday, June 12, 1980 from 10:00 a. m. to 6:00 p. m.

Please contact Mr. D. O. Regalado, Principal, at North Dallas High School, 521-3103 or my office 824-1620, extension 447 if we can be of further assistance to you.

Sincerely,

R. S. Andrews
Assistant Superintendent-
Business Services

RSA:vs
cc: Mr. D. O. Regalado
Mr. William H. Cotton
Mr. Paul Arnold
Mr. James Damm

3700 Ross Avenue, Dallas, Texas 75204, 214/824-1620

RECEIVED
APR 11 1980

TEXAS ENERGY AND NATURAL RESOURCES ADVISORY COUNCIL
411 WEST 13TH STREET, AUSTIN, TEXAS 78701

April 4, 1980

Mr. Robert Andrews
Dallas Independent School District
700 Ross
Dallas, TX 75204

Dear Mr. Andrews:

The Texas Energy and Natural Resources Advisory Council created in December, 1979 the Solar Advisory Committee. Its mission is to develop a comprehensive statement on the appropriate role of the State of Texas in supporting research, development, demonstration, commercialization, and information dissemination activities related to solar and wind energy. The twenty-one member advisory committee is chaired by Mack Wallace, Commissior of the Railroad Commission.

In an effort to solicit public participation, the Solar Advisory Committee will conduct five public hearings throughout Texas: El Paso, Lubbock, San Antonio, Dallas, and Houston. The Committee desires to hold the Dallas public hearing on June 12, 1980 at North Dallas High School. As North Dallas High School is the largest solar heating project in Dallas, the school would be an excellent location for the solar public hearing.

The public hearing would be held on Wednesday, June 12 from 10:00 a.m. to 6:00 p.m. A school auditorium would be the most likely hearing area so as to accomodate the twenty committee members and 100 to 150 citizens. If the Dallas Independent School District is amenable to the hearings, specifics such as tables and microphones can be detailed at a future date.

Thank you for your consideration and I look forward to hearing from you.

Sincerely,

John H. Carlson
Program Coordinator for Commercial and Solar

JHC:mld

R. S. Andrews
Assistant Superintendent
Business Services

Date APR 1 1 [illegible]
Wright
Cotton
File
For Info

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Co-Chairmen:
William P. Clements, Jr.
Governor
William P. Hobby
Lieutenant Governor
Vice-Chairman:
Bill Clayton
Speaker of the House
Executive Director:
Milton L. Holloway

Submittal of Report

The following correspondence represents the final submittal before the transfer of this project to the Southern Regional Solar Energy Center (SREC) for DOE project monitoring.

dallas independent school district

May 5, 1980

Linus Wright
General Superintendent

PMK May 6
Received

Mr. W. A. Hagen
Operational Test Site Manager
Solar Heating and Cooling Program, FA33
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Re: N. Dallas High School Solar
Project, Dallas, Texas
Contract EM-78-FO1-5204

Dear Mr. Hagen:

Under separate covers via U.S. Postal Service Parcel Post we forwarded to you on May 2, 1980 the following:

(1) 1 roll consisting of 2 bound sets of "as-built" prints of the North Dallas High School Solar Heating and Domestic Hot Water System installation.

(2) 1 package consisting of one (1) set of construction specifications, complete with all addendums, of the project and one (1) complete copy of the project Operating and Maintenance Manual for the installation.

Attached are two (2) copies each of the detailed project description and the final acceptance test run. The system was first tested and logged on a preliminary basis for five (5) continuous hours from sun-rise until 12:40 P.M. on December 4, 1979. This is counted as the official start-up date for the system.

Based on the results obtained in the December 4 test, additional balancing valves were installed in the return solar water mains from each of the two solar panel fields to allow flow balancing which would assure equal solar water temperatures off each of the two equal area panel fields. Also added was a calibrated pitot type flow measuring device (annubar) in the main solar water supply line to the solar panels to allow almost exact design flow adjustment.

3700 Ross Avenue, Dallas, Texas 75204, 214/824-1620

A final acceptance test of two hours based on these changes plus commensurate flow adjustments was then run on January 17, 1980, which is attached. We are highly pleased with the system performance and have had no difficulties to date other than two minor freezes in isolated arrays, apparently caused by individual vacuum breakers sticking on drain-down cycle. Panel header ends which ruptured were easily repaired.

Monthly natural gas consumption for the building since start-up of the solar system is as follows:

December, 1979	-	605.5 MCF
January, 1980	-	554.6 MCF
February, 1980	-	709.0 MCF
March, 1980	-	173.0 MCF

We will advise monthly gas consumption to complete the first 12 months of operation, but the system will not be in operation during June, July and most of August since the building will have no hot water usage during the period when school is not in session.

Attached for your information are copies of correspondence concerning usage of the project location as a State sponsored solar energy conference site on June 12, 1980.

We trust that this data will bring the project up to current status as to required documentation.

Sincerely,

F. P. Arnold, P. E.
Chief Engineer

FPA:djt
Attachments

APPENDIX A - SPECIFICATIONS

The Specification for Solar Modification, Existing Building Heating and Domestic Hot Water Systems, October 30, 1978, is available for review at the North Dallas High School, Dallas Independent School District, Dallas, Texas 75204, should you require this 200 page document.

Architect is:

Foster & Meier Architects
Architects and Planners
800 LTV Tower
Dallas, Texas 75201
Phone: 214 - 748-5055

Mechanical, Electrical and Solar is:

William K. Hall Company
4350 N. Central Expressway
Dallas, Texas 75206
Phone: 214 - 826-8831

The index of this document follows and is included as part of this final report.

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APPENDIX B - SOLAR MODIFICATION

A 250 page Solar Modification, North Dallas High School Operation and Maintenance Instructions Document has been compiled by the Burden Service Company, P.O. Box 4425, Dallas, Texas 75208, telephone (214) 942-4475.

The operating instructions, Solar System - North Dallas High School and the index to solar modifications is included as part of this final report. Should detail information be required contact the North Dallas High School or the Southern Regional Solar Energy Center (SREC), Atlanta, Georgia.

Burden Service Company

Burden Service Company
P.O. Box 4428
Dallas, Texas 75208
214 942-4475

Service Dept. & Receiving
1321 Plowman Ave
Dallas, Texas 75208
214 942-1696

OPERATING INSTRUCTIONS

SOLAR SYSTEM - NORTH DALLAS HIGH SCHOOL

WINTER - Building and Hot Water Heating

Position selector switch on master panel to "WINTER" position. Check water level in solar storage tank for proper operating level. Start pump "P-1" at start-stop station on master panel. Start all air handling units as required, and boilers if desired. Place HOA switches pumps "P-3", "P-4", "P-5", and "P-6" in auto position.

For most desirable results, system should be started as early in the day as possible, to assist rapid filling of the collector panel arrays. This minimizes sudden steam accumulation in the arrays.

SUMMER - Hot Water Heating Only

Position selector switch on master panel to "SUMMER". Turn "P-1" and "P-3" pump switches off. At this point proceed with previous standard chilled water start-up.

CAUTION

Always check water temperature gauges on master panel to be sure heating water to building is not over 110°.

Whenever solar return water temperature is over 190° go up to roof and check both sides of roof to see if steam is blowing off. If steaming-call HVAC Maintenance at once. Low water level and high water level is indicated by audible alarm. Tank drains through valve #46. Tank fills through valve #3. Proper operating level is indicated on site glass.

Burden Service Company

Burden Service Company
P.O. Box 4475
Dallas, Texas 75208
214 942 4475

Service Dept. & Receiving
1321 Plowman Ave
Dallas, Texas 75208
214 942-1696

SOLAR MODIFICATIONS

NORTH DALLAS HIGH SCHOOL

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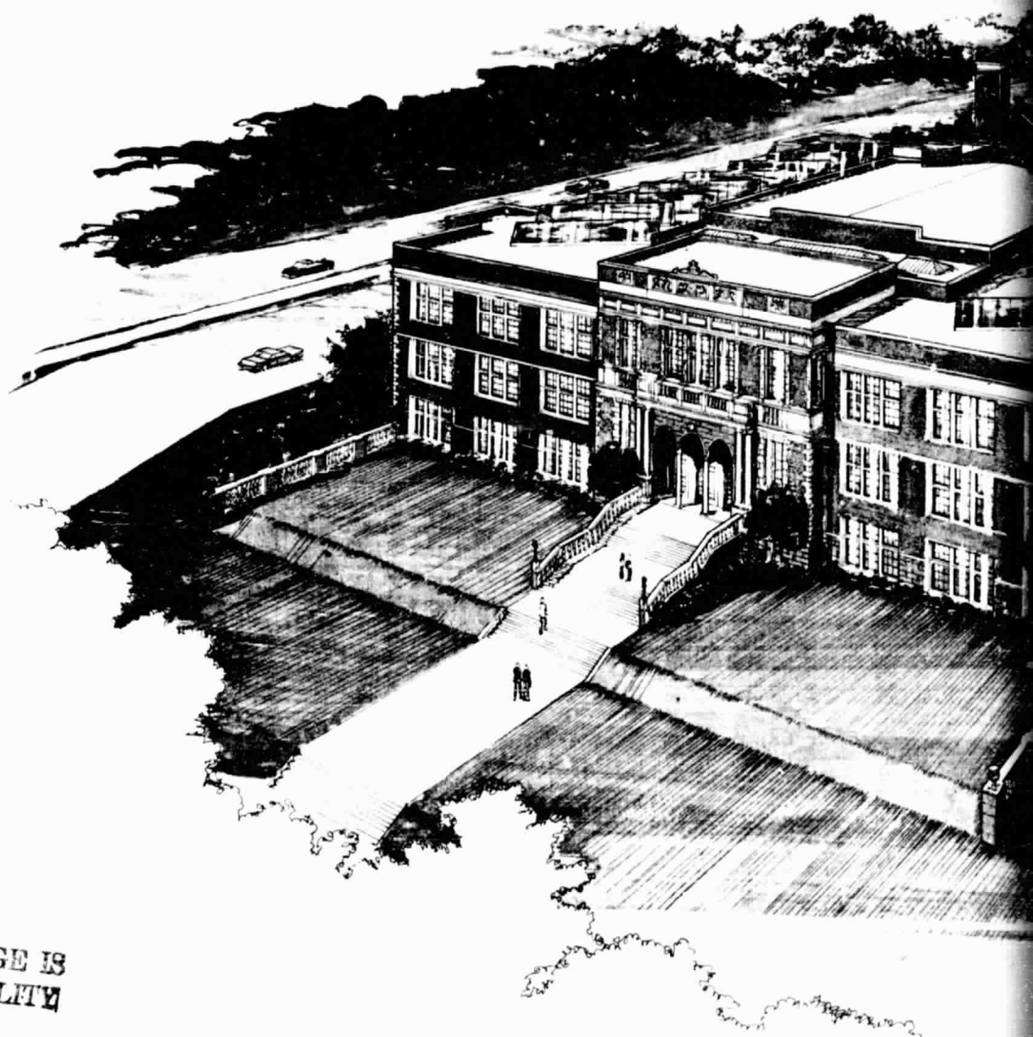
	Pages
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APPENDIX C - DRAWINGS

A set of fifteen 30" x 42" size "as built" drawings have been used in the modification of this site for solar energy application. The index to these drawings and a reduced size reproduction are part of this appendix and this final report.

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NORTH DALLAS HIGH SCHOOL

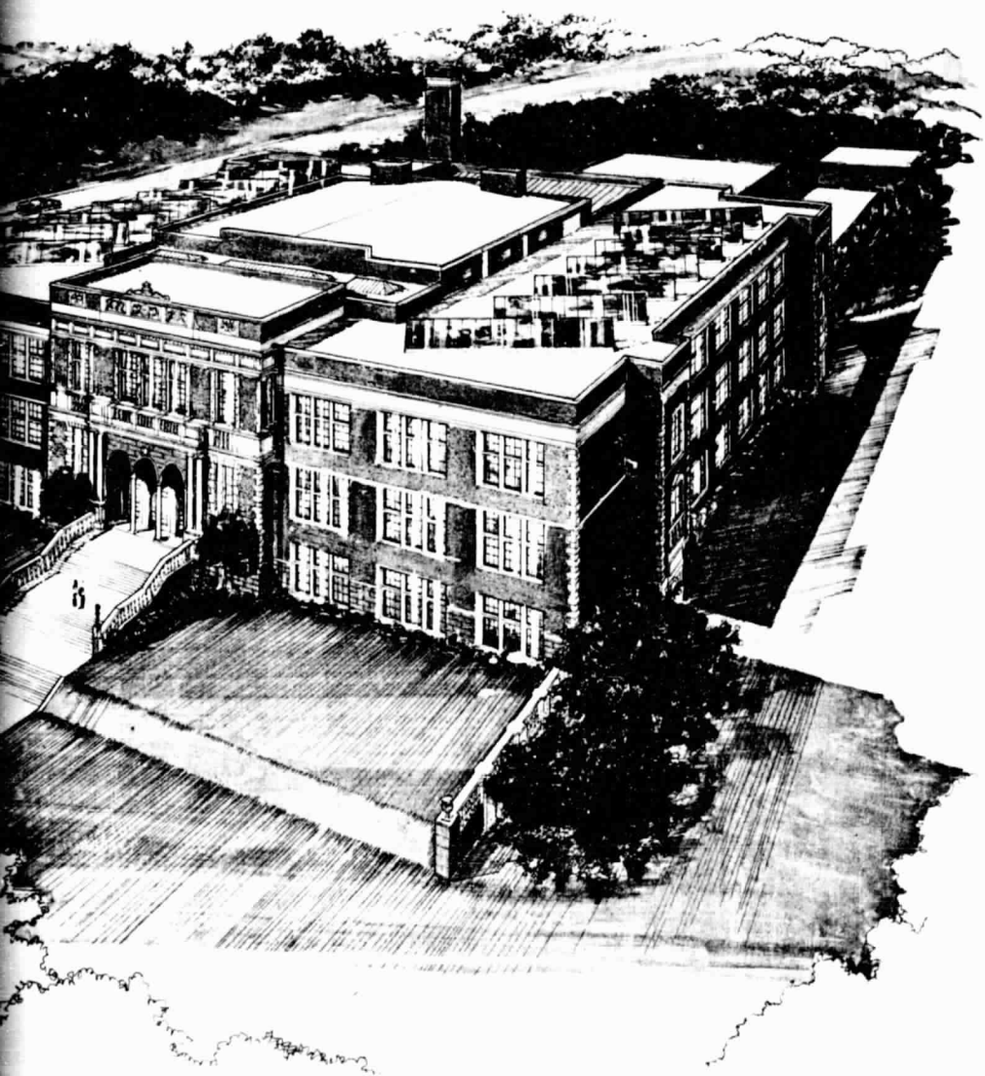
DOE

EM 78 F01 5204

FOLDOUT FRAME

FOSTER + MEIER ARCHITECTS INC.
ARCHITECTS

F. P. ARNOLD, JR., P.E.
PROJECT MANAGER – D.I.S.D.



FOLDOUT FRAME 2

EM FOR HEATING AND DOMESTIC HOT WATER

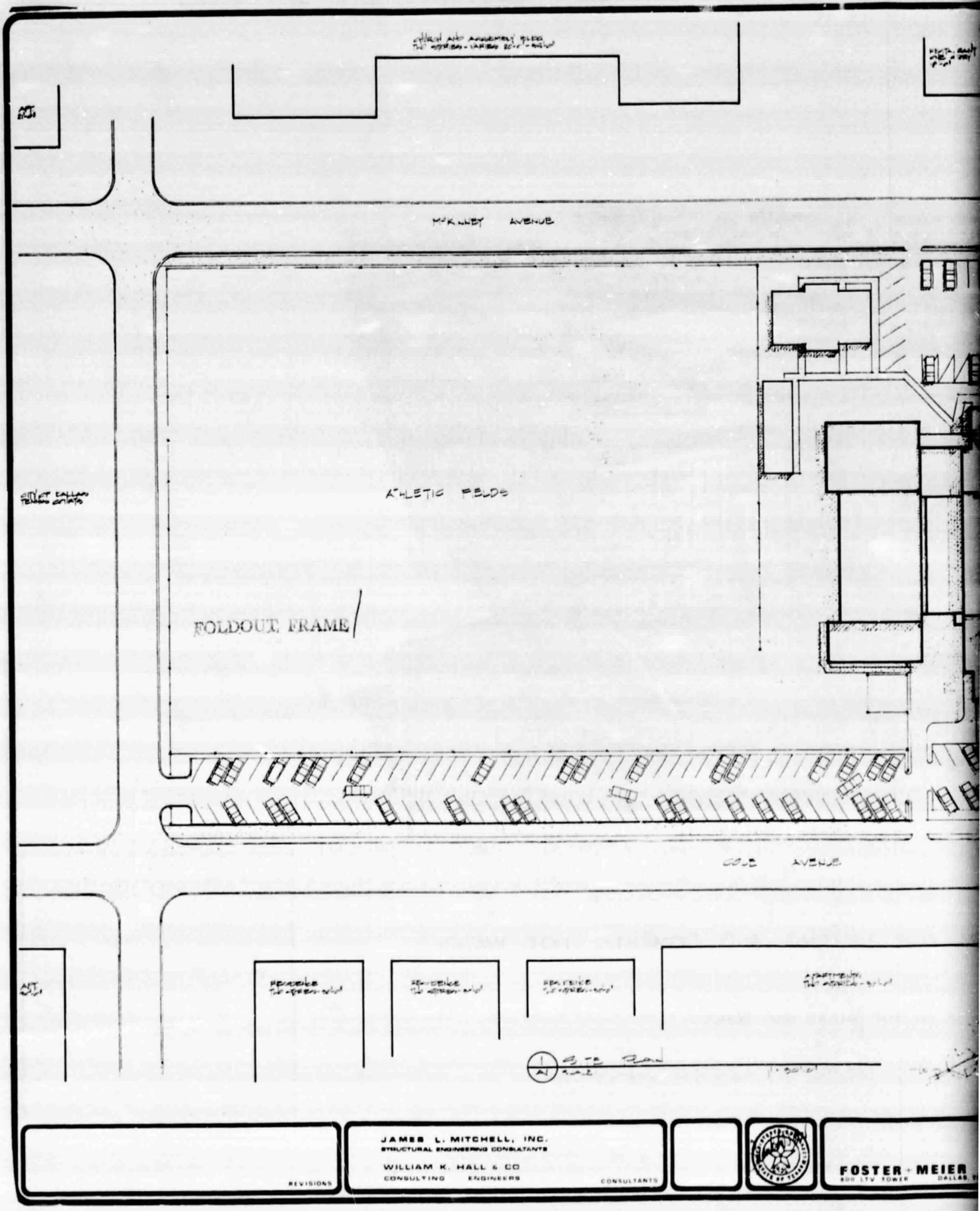
NORTH DALLAS HIGH SCHOOL

DOE

EM 78 F01 5204

F. P. ARNOLD, JR., P.E.
PROJECT MANAGER – D.I.S.D.

WILLIAM K. HALL AND CO.
MECHANICAL AND ELECTRICAL ENGRS.



SITE PLAN

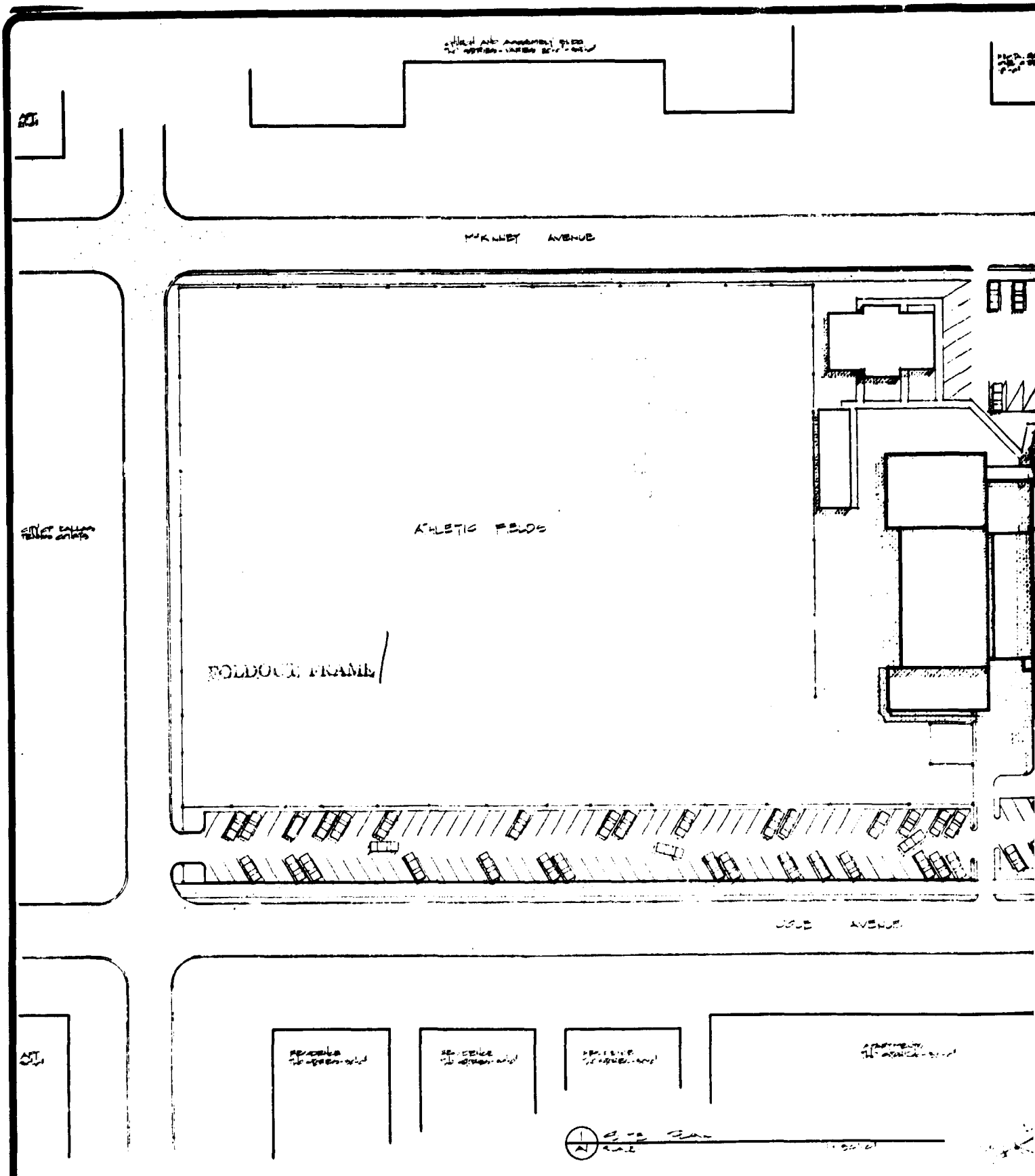
JAMES L. MITCHELL, INC.
STRUCTURAL ENGINEERING CONSULTANTS

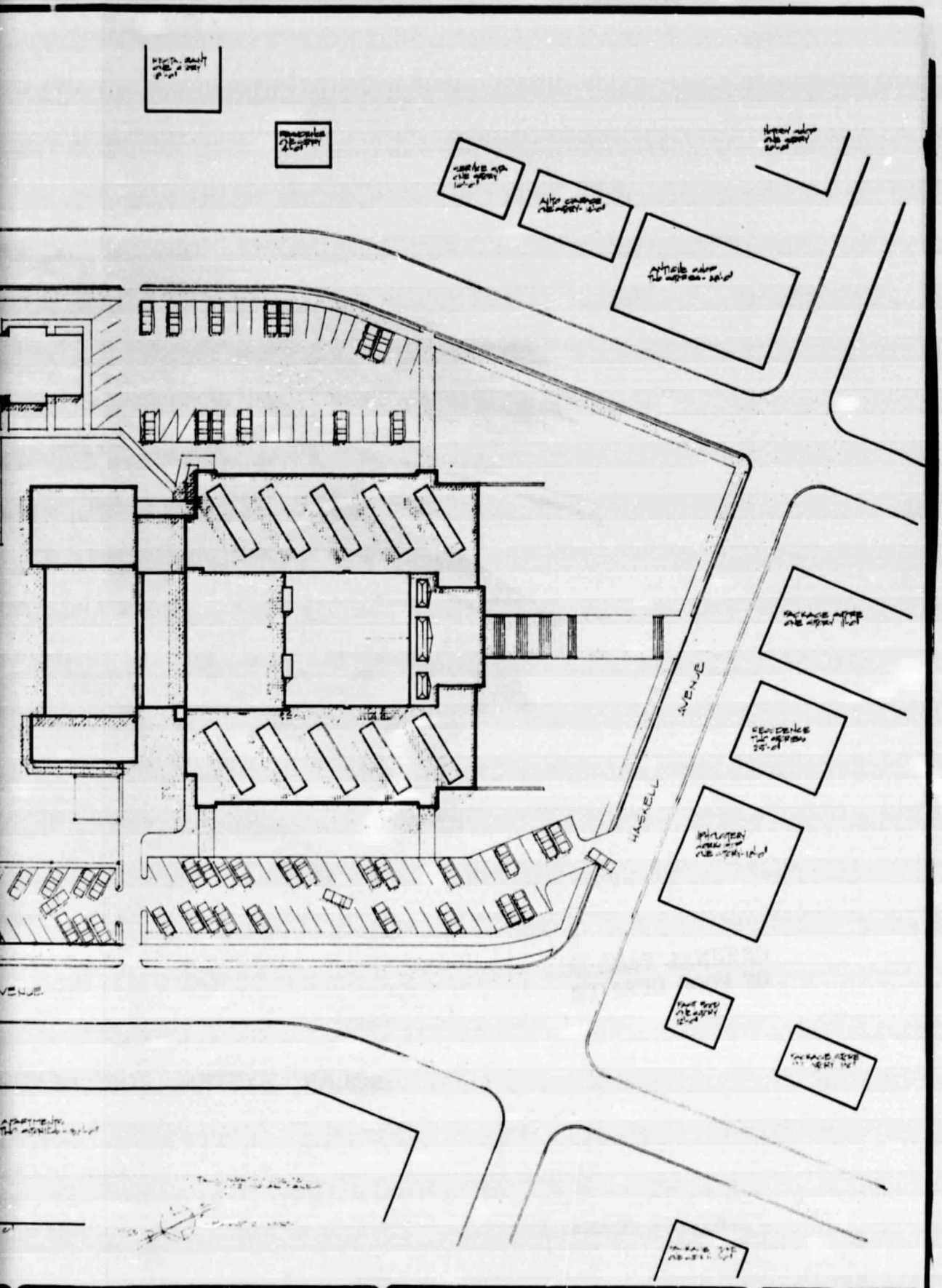
WILLIAM K. HALL & CO
CONSULTING ENGINEERS

REVISIONS

CONSULTANTS

FOSTER + MEIER


PICKWICK AVENUE
ATHLETIC FIELDS
FOLDOUT FRAME
JAMES L. MITCHELL, INC.
STRUCTURAL ENGINEERING CONSULTANTS
WILLIAM K. HALL & CO
CONSULTING ENGINEERS
REVISIONS
CONSULTANTS
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FOSTER · MEIER ARCHITECTS, INC.
800 LTV TOWER DALLAS TEXAS 75201 214 748-5055

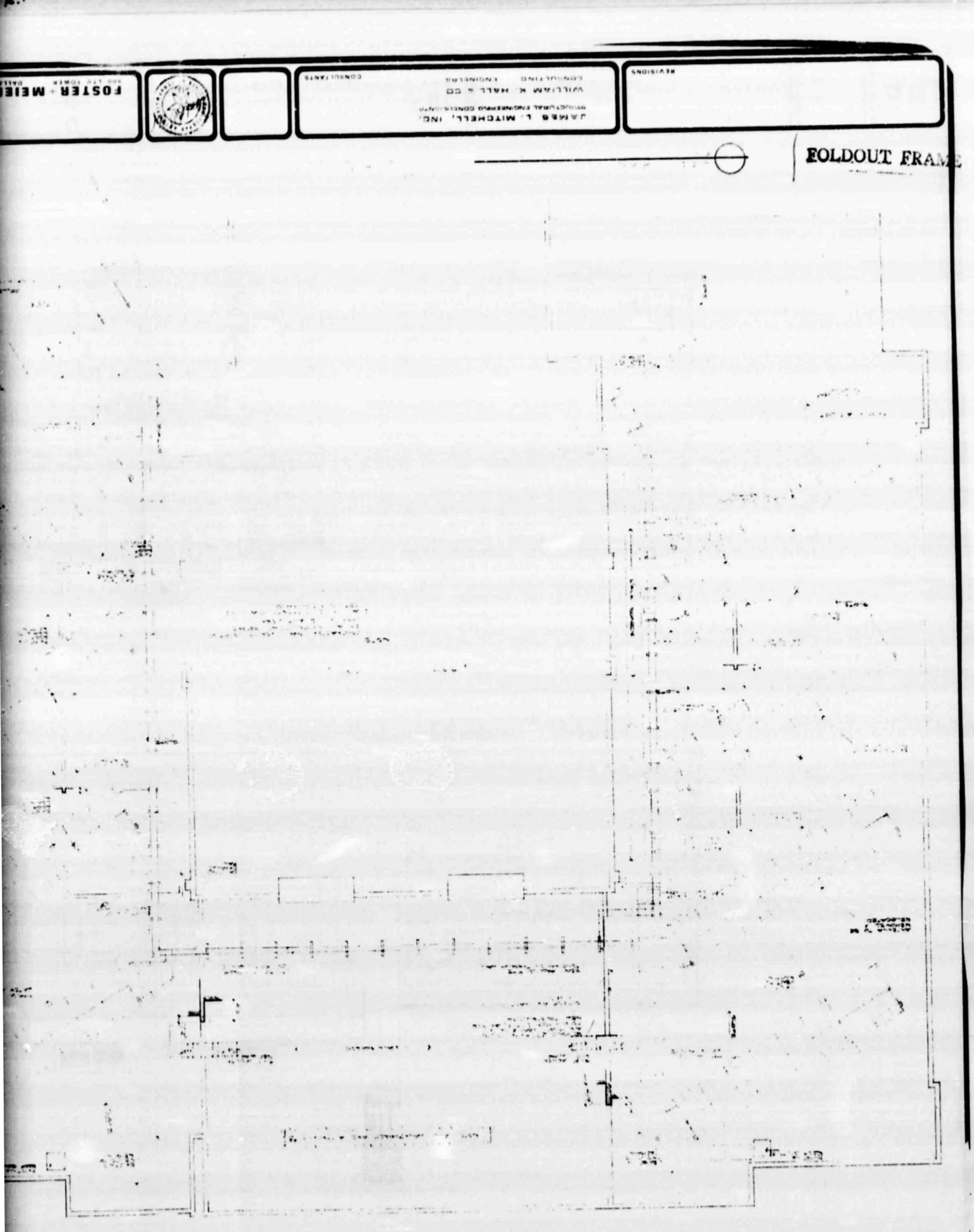
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OF
EXISTING BUILDING HEATING & DOMESTIC HOT WATER SYSTEMS
NORTH DALLAS HIGH SCHOOL
DALLAS INDEPENDENT SCHOOL DISTRICT

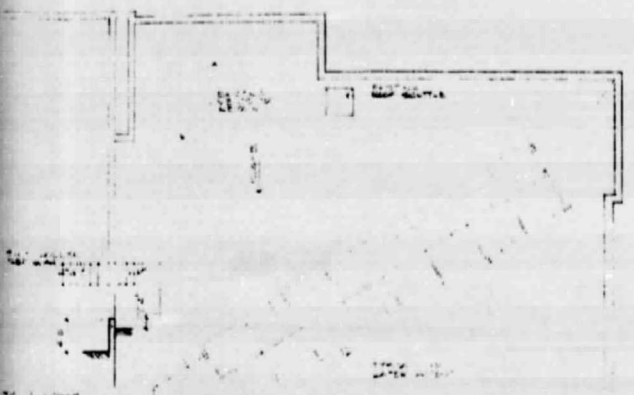
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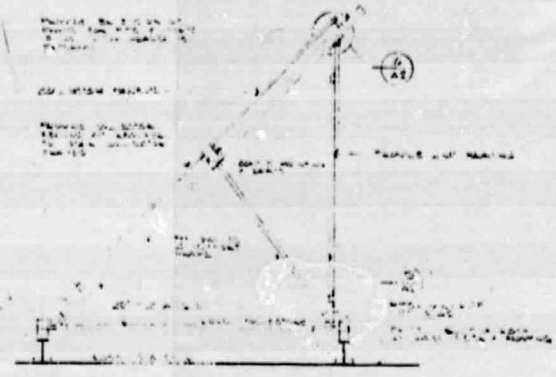
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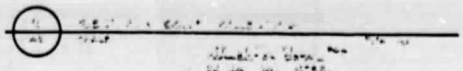
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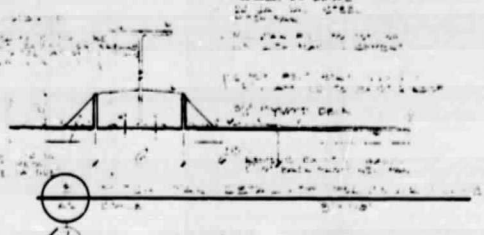
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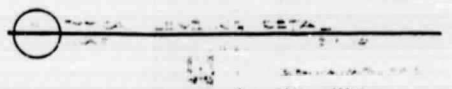

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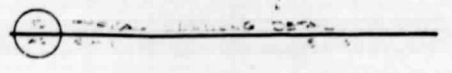












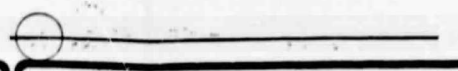


GENERAL NOTES ON COLLECTOR FRAMES

1. A-FRAME SPACINGS TO BE DETERMINED BY LOAD OF COLLECTORS, WIND, AND COLLECTOR DESIGN
2. DESIGN OF SOLAR COLLECTOR FRAME SHALL UNIFORMLY DISTRIBUTE LOAD TO EXISTING ROOF DECK.
3. PROVIDE CONTINUOUS STEEL SUPPORTS SET IN FITCH PANS AT EACH LINE OF COLLECTOR FRAME.
4. ERECTION SHALL BE LIMITED TO [illegible] OF CRANE.
5. PROVIDE DESIGN CALCULATIONS ON SOLAR FRAME STRUCTURE (WITH SHOP DRAWINGS) CALCULATIONS SHALL INCLUDE TYPE OF ERECTION PROPOSED.
6. SUPPORT BEAMS FOR ALL COLLECTORS SHALL BE LAID OUT ON ROOF PRIOR TO SUBMITTING SHOP DRAWINGS.

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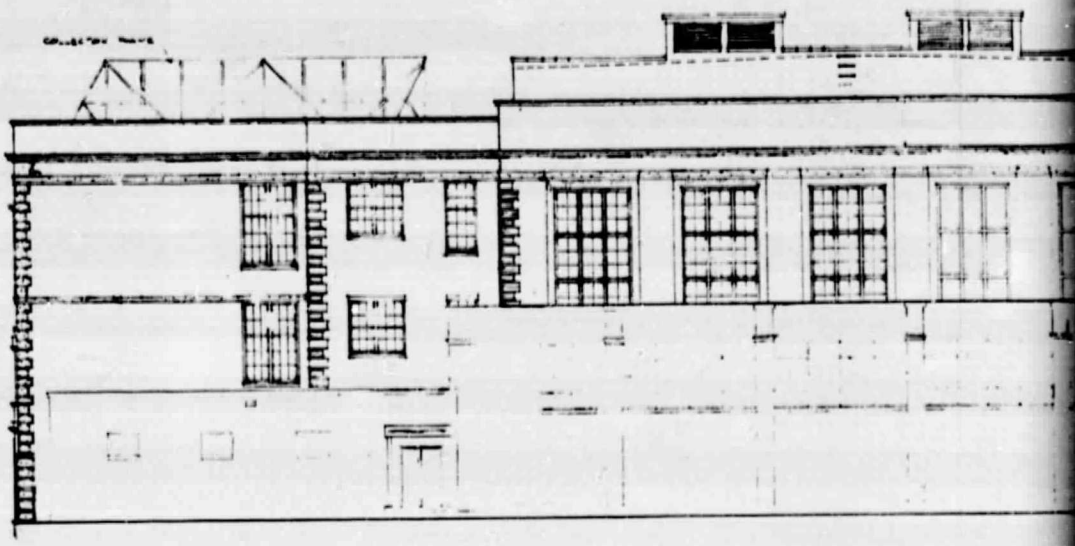


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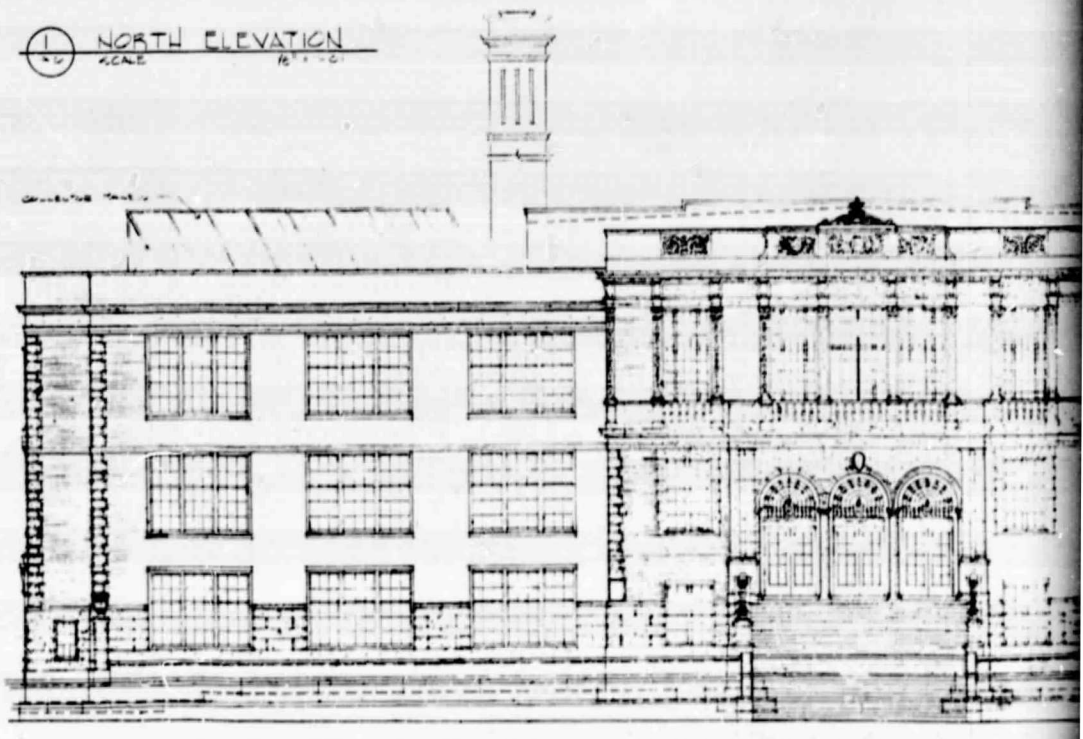
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NORTH DALLAS HIGH SCHOOL
DALLAS INDEPENDENT SCHOOL DISTRICT

LAST ISSUE
DATE
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SHEET NO A2
SEQUENCE NO 1



1 NORTH ELEVATION
SCALE



2 SOUTH ELEVATION
SCALE

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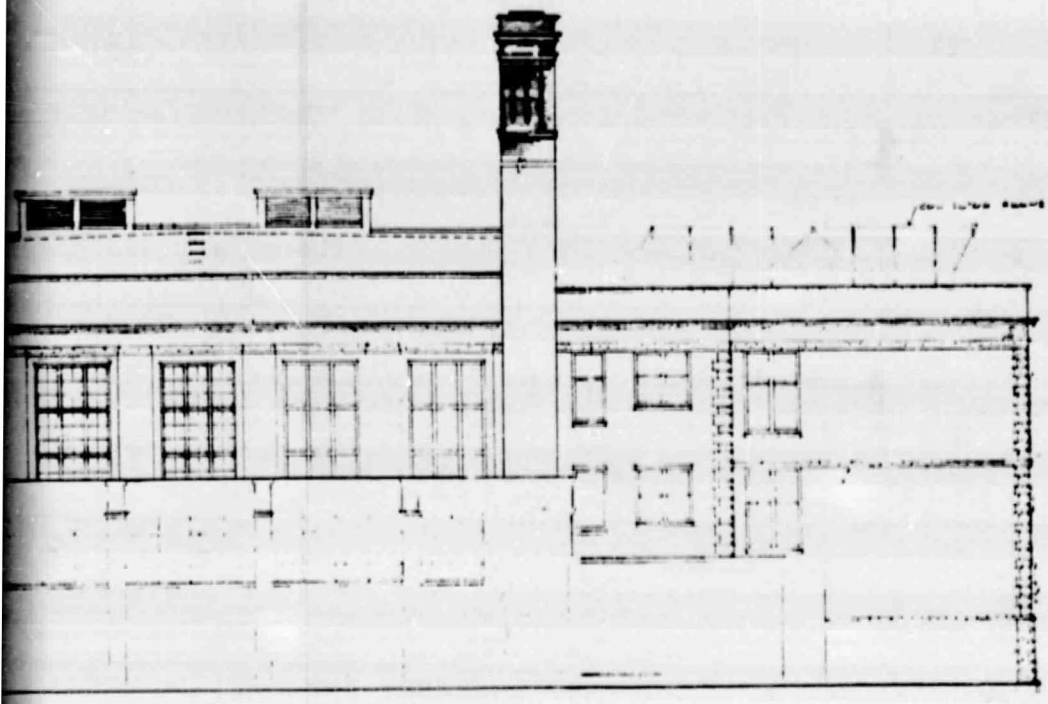
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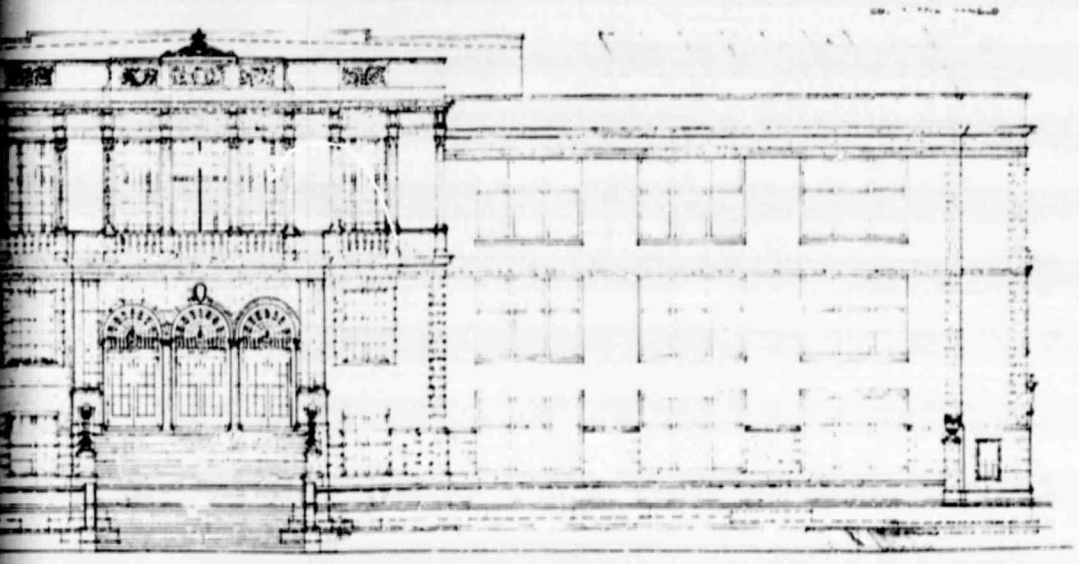
JAMES L. MITCHELL, INC.
STRUCTURAL ENGINEERING CONSULTANTS

WILLIAM K. HALL & CO
CONSULTING ENGINEERS

CONSULTANTS

FOSTER + MEIER
700 LTV TOWER DALLAS





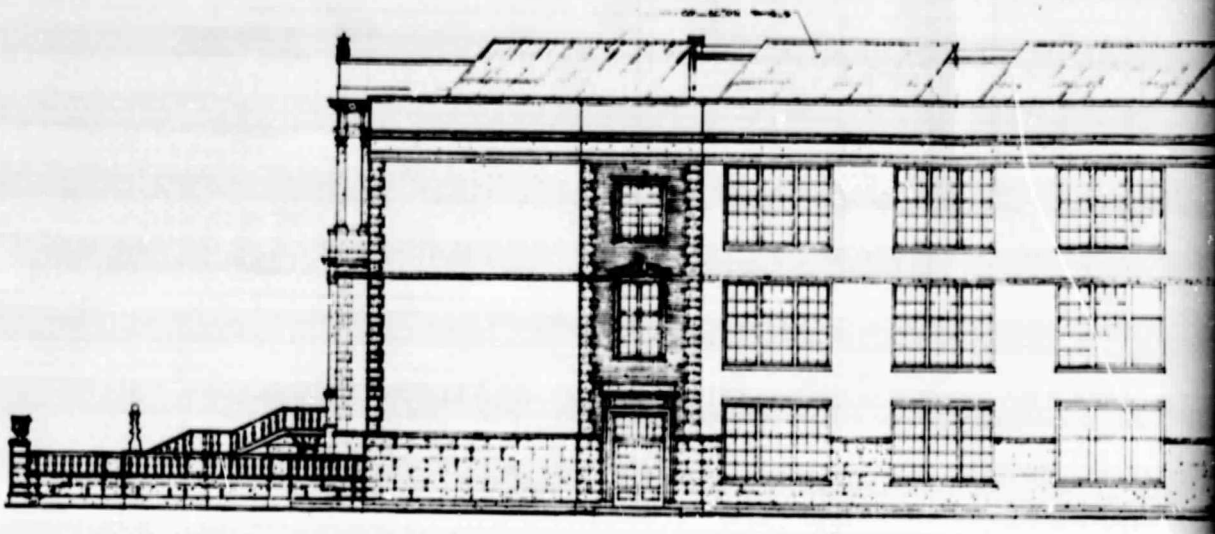
ROLLOUT FRAME 2

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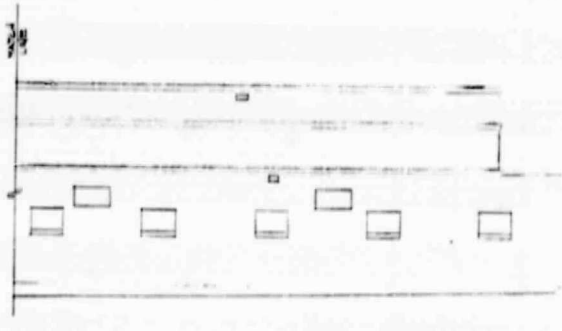
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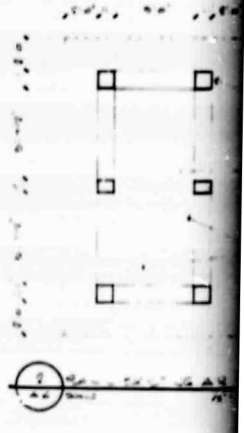
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A3
SEQUENCE NO



1 EAST ELEVATION





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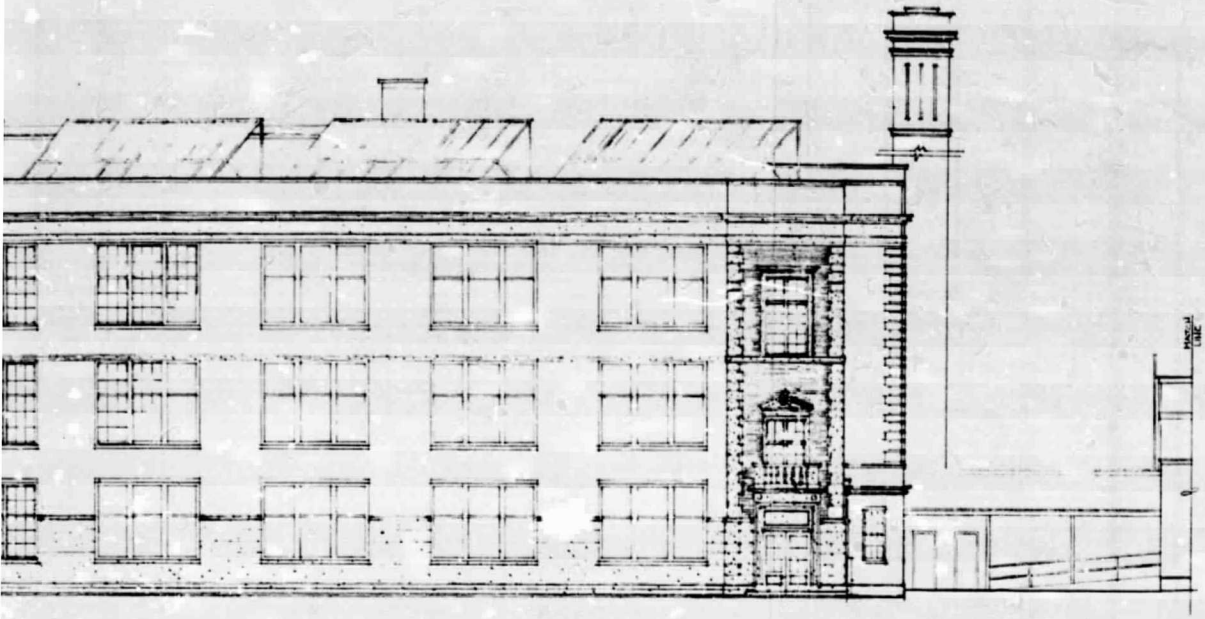
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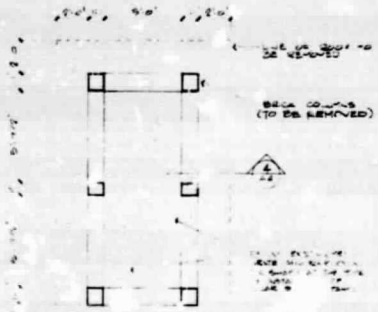
REVISIONS

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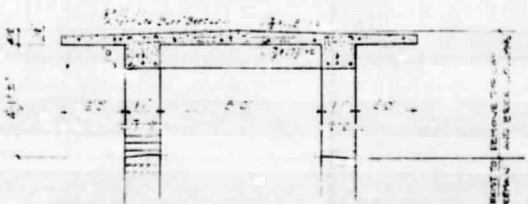
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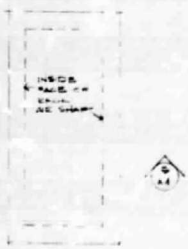


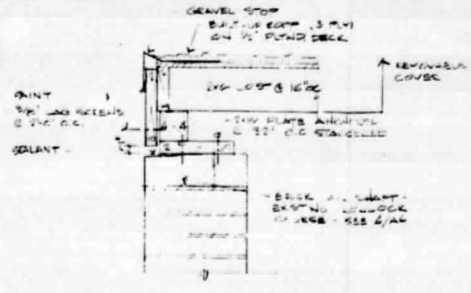


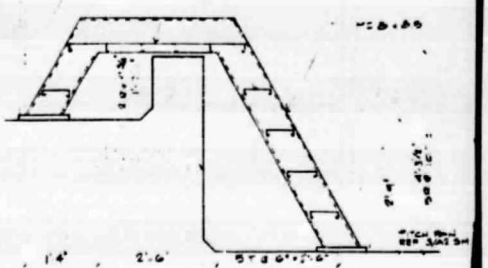
FOLDOUT FRAME 2



(4/A4) SECTION @ AIR SHAFT (NEW ENG)
SCALE: 1/2"=1'-0"







(3/A4) P.I.C. REVISED AIR SHAFT
SCALE: 1/2"=1'-0"

(10/A4) DETAIL @ AIR SHAFT CAP
SCALE: 1/2"=1'-0"

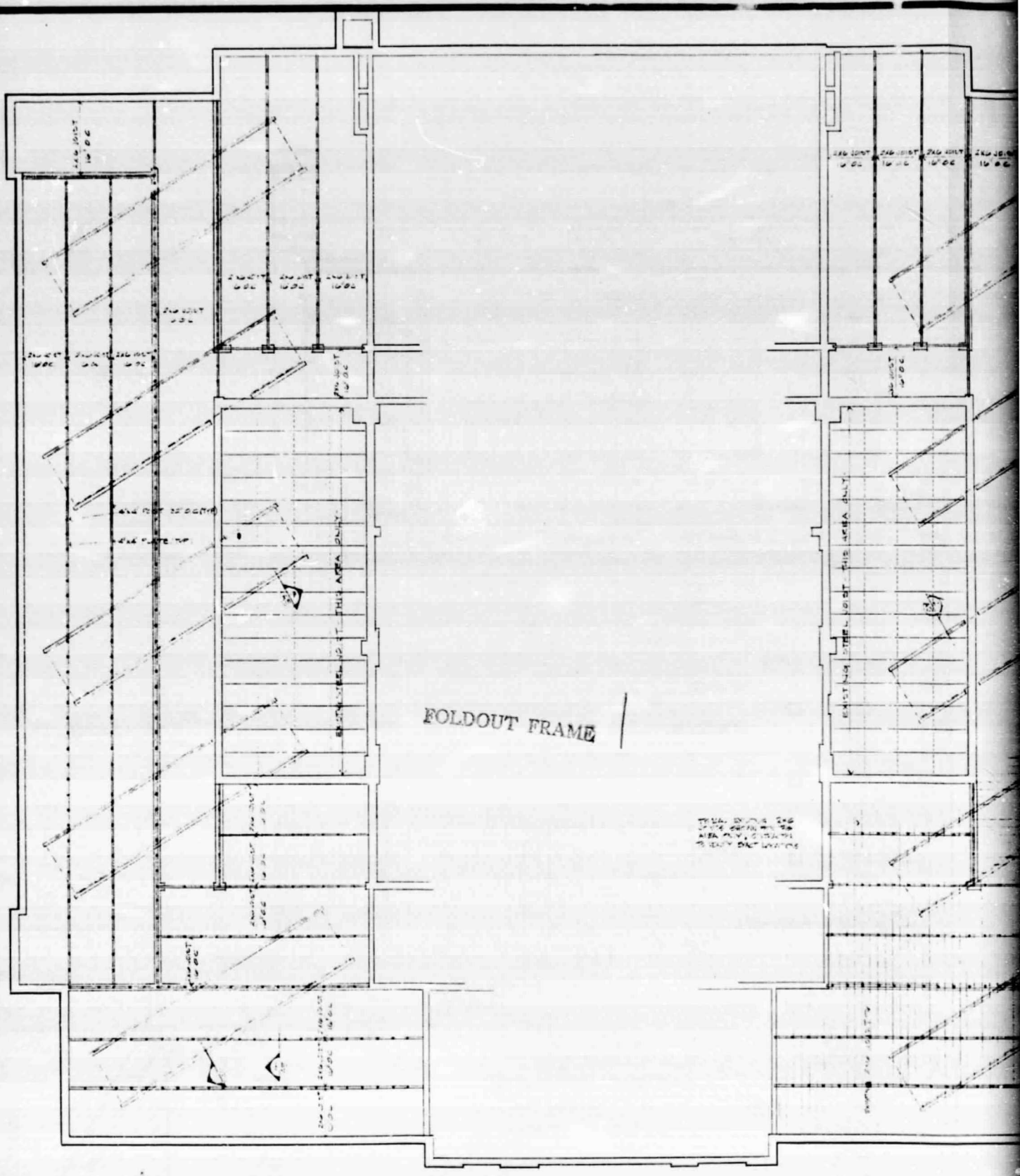
(6/A4) SHIPS LADDER DETAIL (PAGE 6.)

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DALLAS INDEPENDENT SCHOOL DISTRICT

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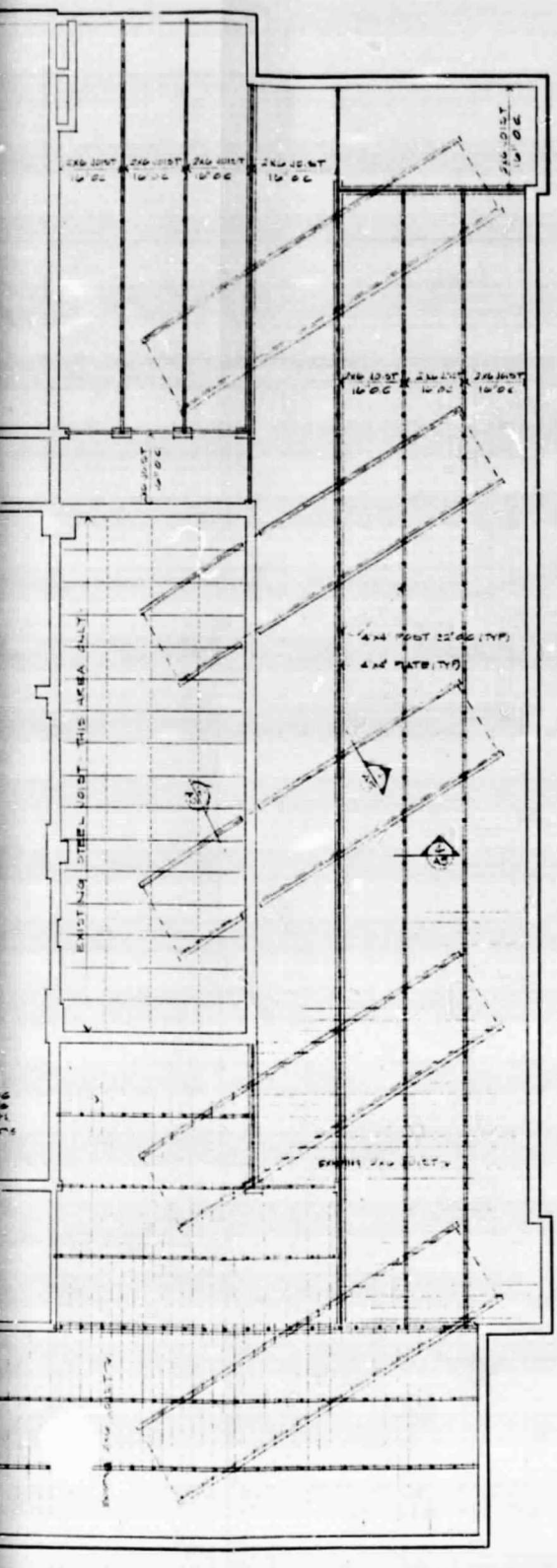
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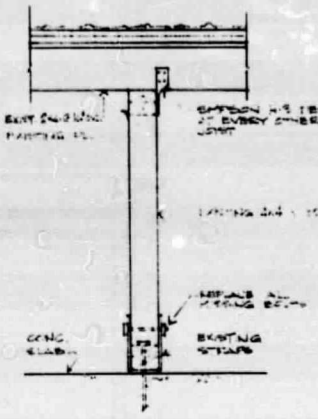


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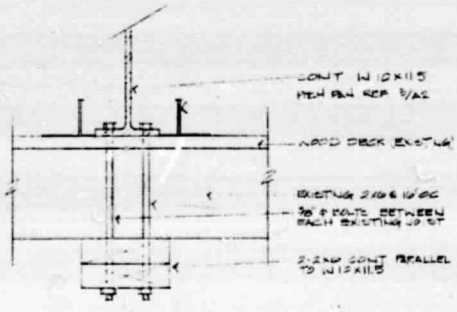
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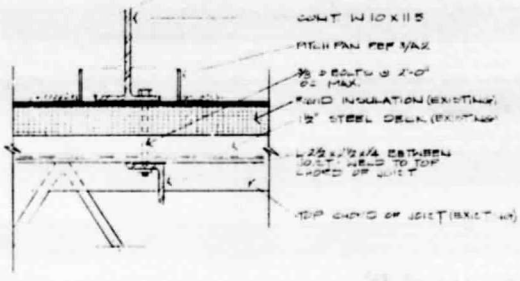


4/A5 DETAIL (TYP)



NOTE:
EXISTING 2x6 JOIST ARE SUPPORTED BY ROWS OF 4x4 POSTS @ 32" OC WITH 2-2x4 PLATES TOP & BOTTOM. METAL STRAPS WERE PROVIDED AT TOP & BOTTOM TO TIE JOISTS TO POSTS AND POSTS TO CONC. SLAB BELOW. HOWEVER STRAPS ARE NOT PROPERLY BOLTED REPLACE ALL MISSING BOLTS AT BOTTOM STRAPS. PROVIDE SIMPSON H2.5 TIES AT EVERY OTHER EXISTING JOIST TO TIE JOISTS TO TOP PLATE SEE DETAIL 4/A5.

3/A5 DETAIL: WOOD FRAMING (TYP)



2/A5 DETAIL: STEEL FRAMING (TYP)

FOLDOUT FRAME 2

TRUE NORTH

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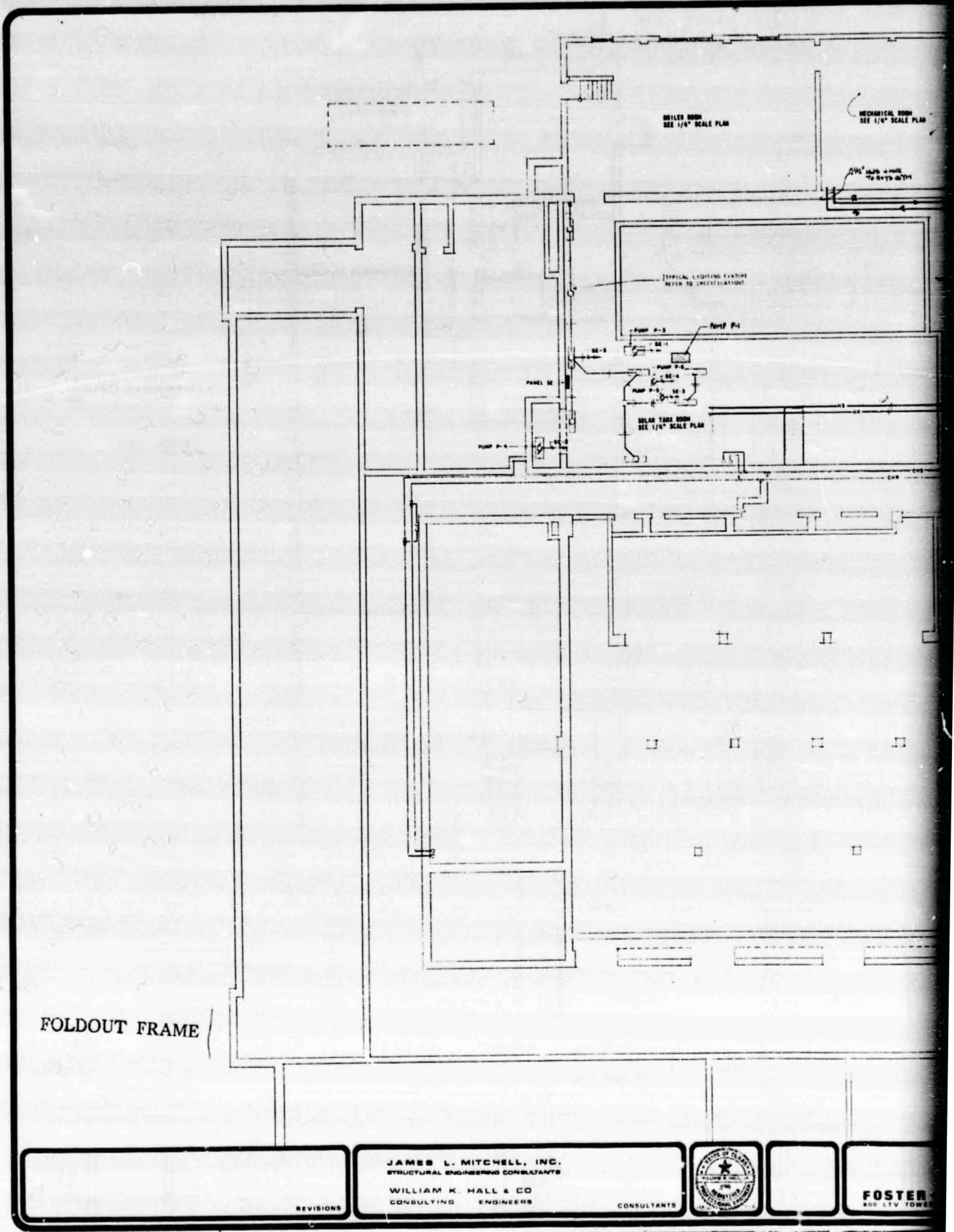
SOLAR MODIFICATION

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SHEET NO. A5
SEQUENCE No. 5



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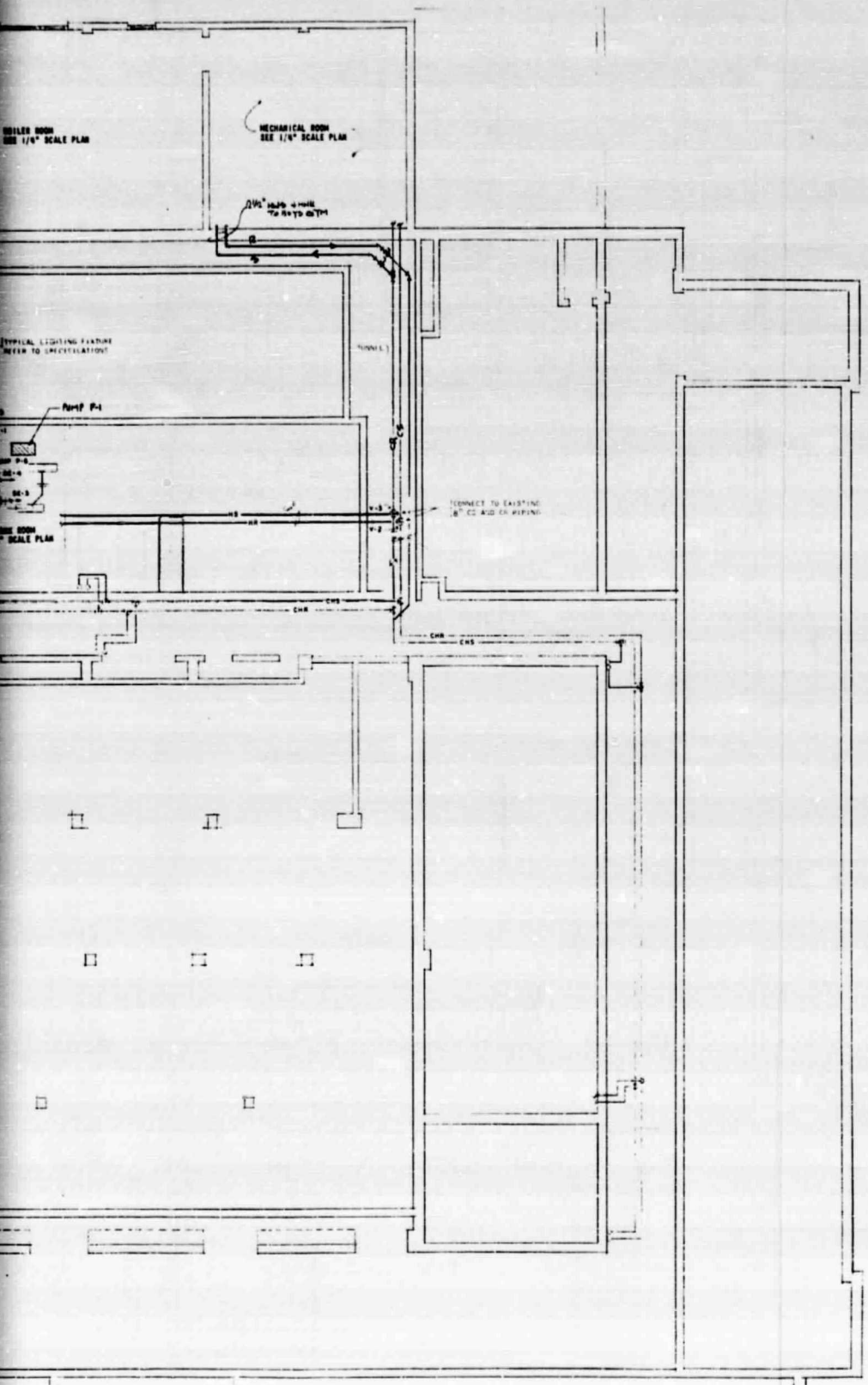
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CONSULTING ENGINEERS

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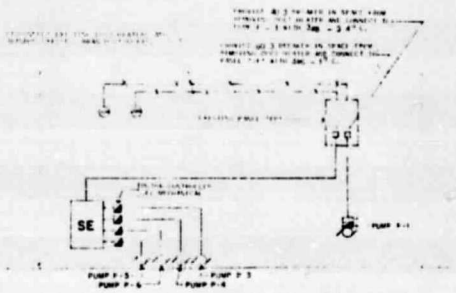
FOSTER

77



PANEL SE SCHEDULE — 120/208 VOLT, 3 PHASE, 4 WIRE + S.N. 60 AMP MAIN LUGS ONLY SURFACE CABINET

CAT. NO.	SERVING	LOAD	BREAKER	FEEDER
SE - 1	PUMP P - 3	3 HP	20 3	3#12 - 3/4" C.
SE - 2	PUMP P - 4	5 HP	40 3	3#10 - 3/4" C.
SE - 3	PUMP P - 5	1.5 HP	20 1	2#12 - 3/4" C.
SE - 4	PUMP P - 6	1.5 HP	20 1	2#12 - 3/4" C.
SE - 5	LIGHTING	1 kW	20 1	2#12 - 3/4" C.
SE - 6	SPARE	—	30 3	
SE - 7	SPARE ONLY	—	30 3	



ELECTRICAL RISER DIAGRAM
SCHEMATIC ONLY

FOLDOUT FRAME 2

BASEMENT AND TUNNEL PLAN
SCALE 1/8" = 1'-0"

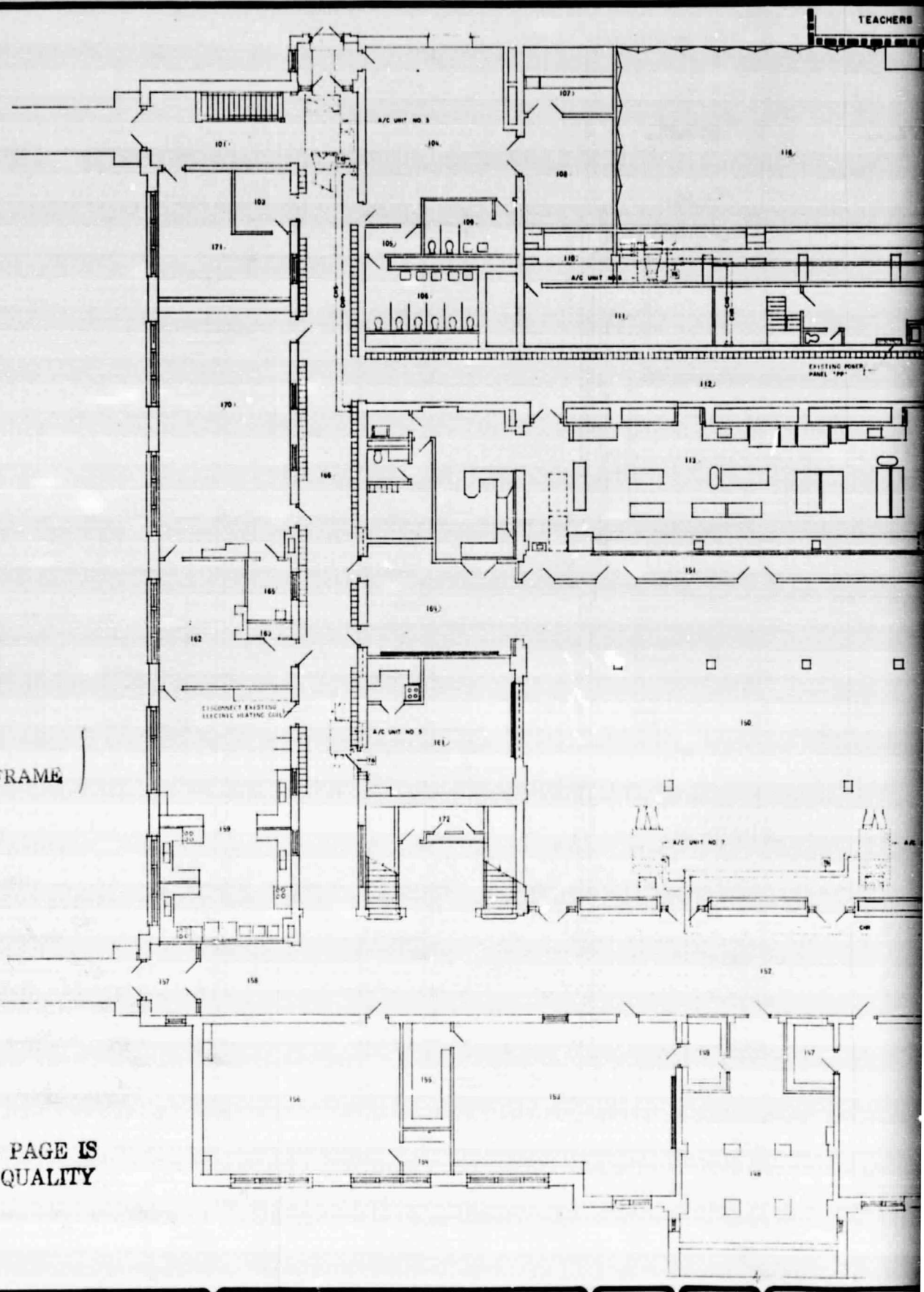
AS BUILT DRAWINGS 9/13/80

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OF
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M-1
SEQUENCE NO.



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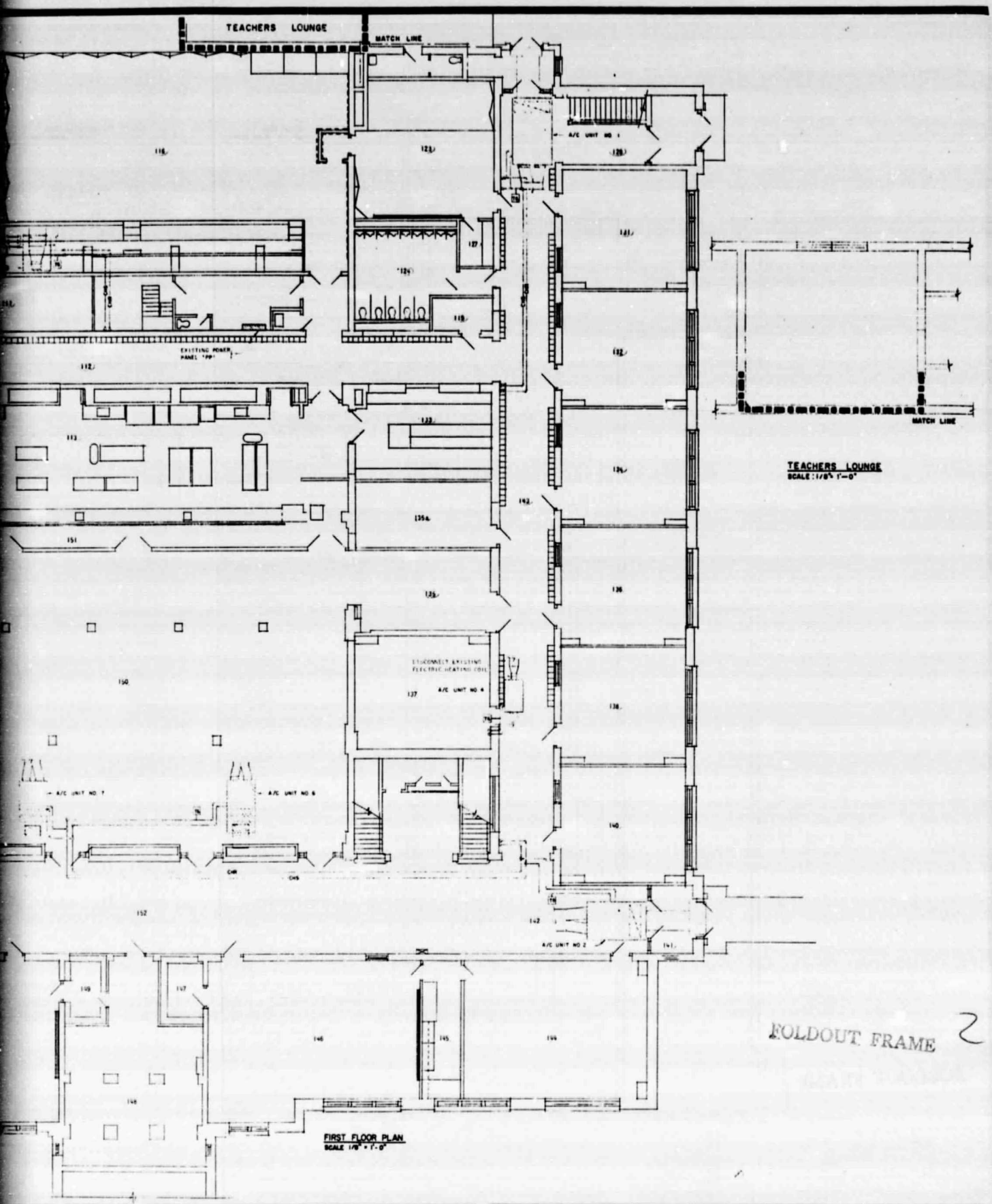
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WILLIAM K. HALL & CO
CONSULTING ENGINEERS

CONSULTANTS

FOSTER + MEI
800 LTV TOWER DA



TEACHERS LOUNGE
SCALE: 1/8" = 1'-0"

FIRST FLOOR PLAN
SCALE 1/8" = 1'-0"

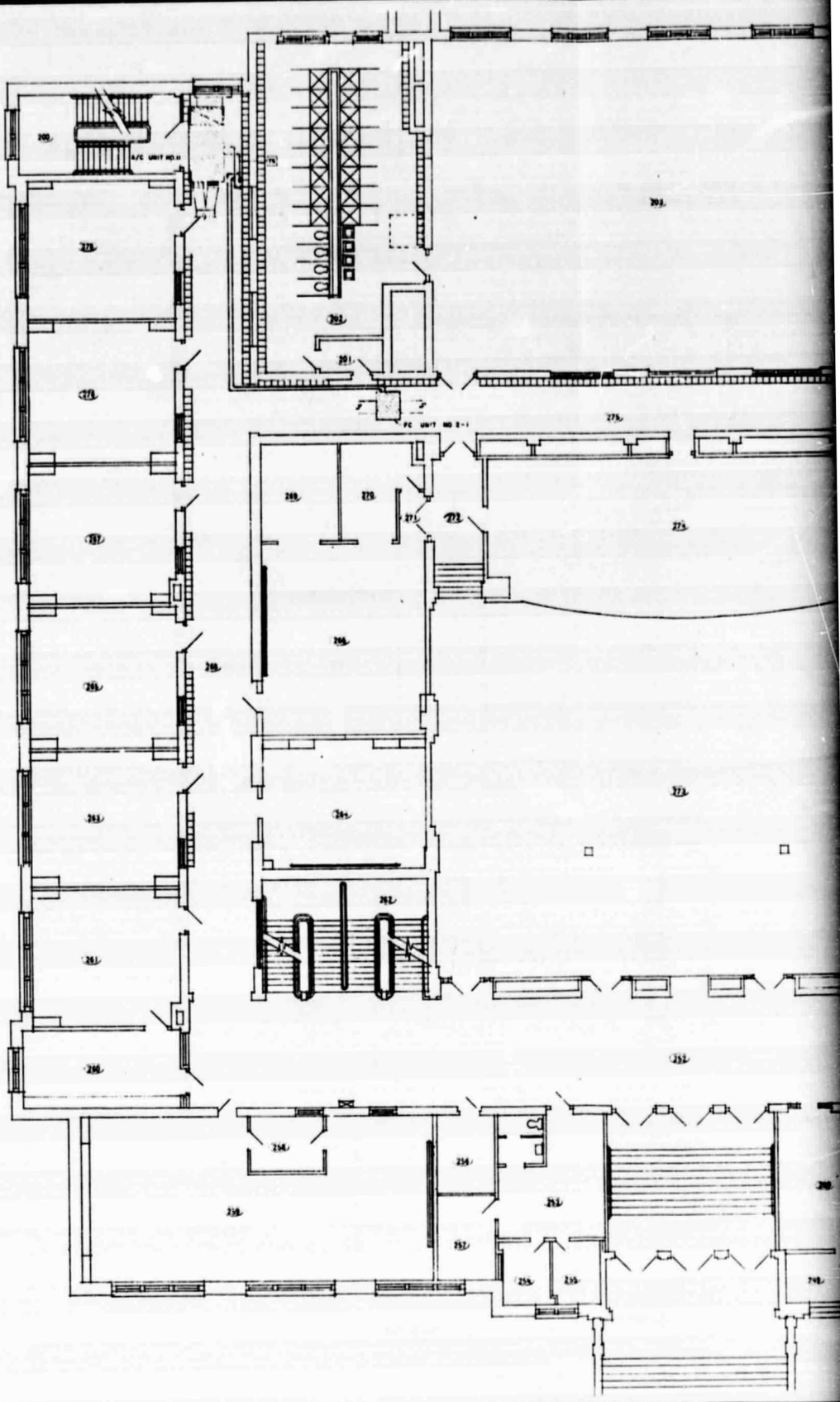
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SEQUENCE NO.
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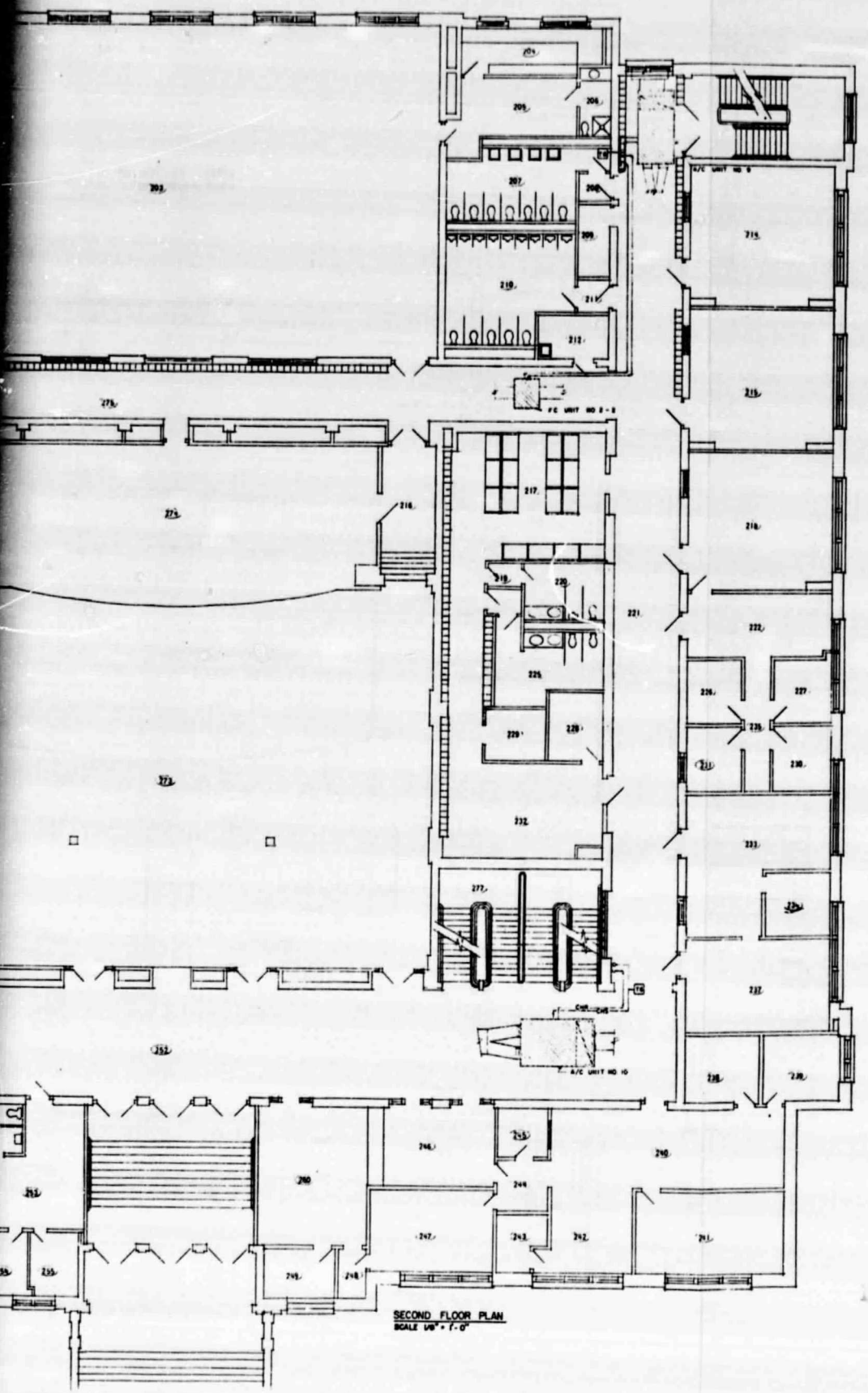


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SECOND FLOOR PLAN
SCALE 1/8" = 1'-0"

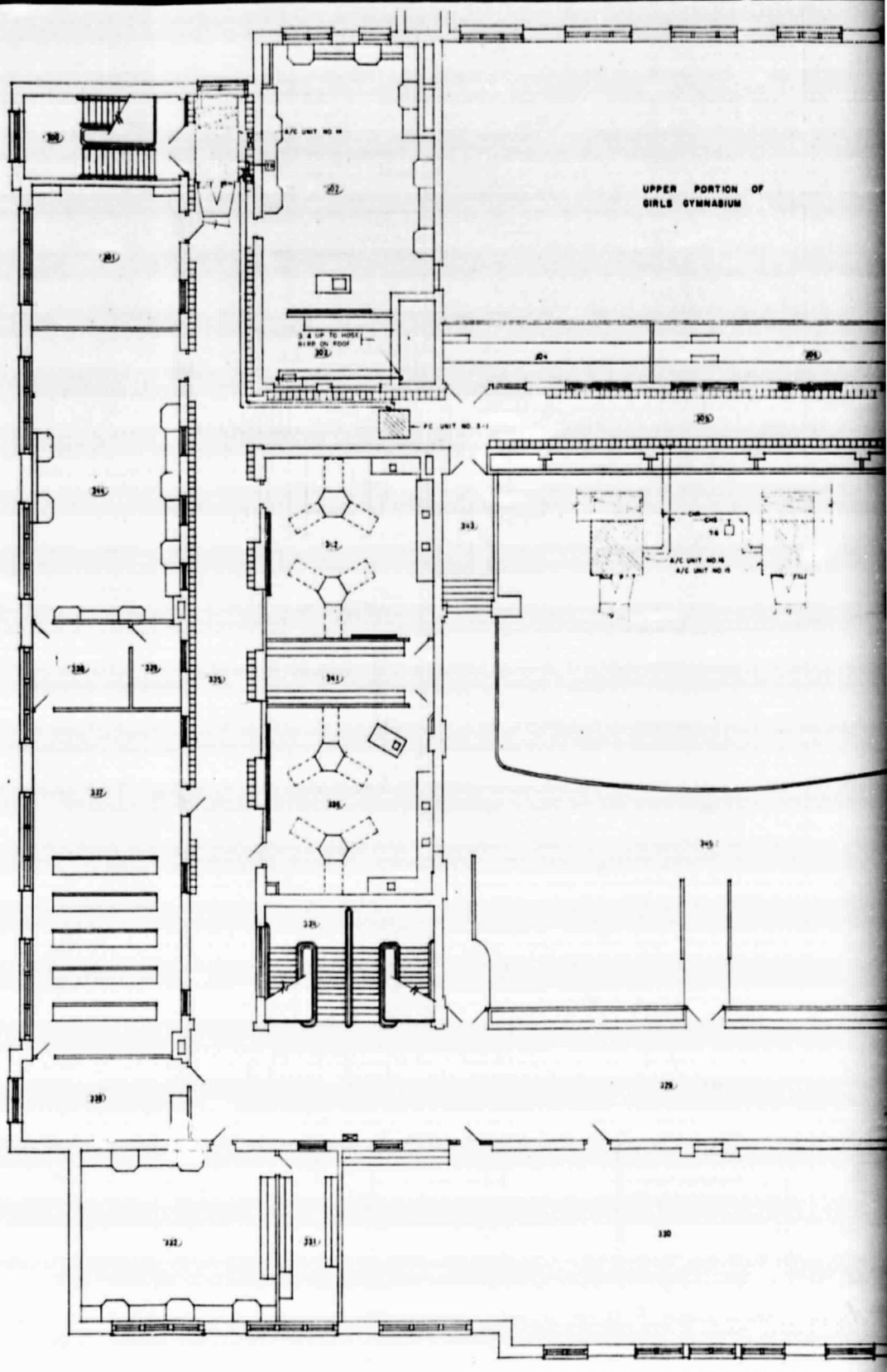
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M-3
SEQUENCE NO.



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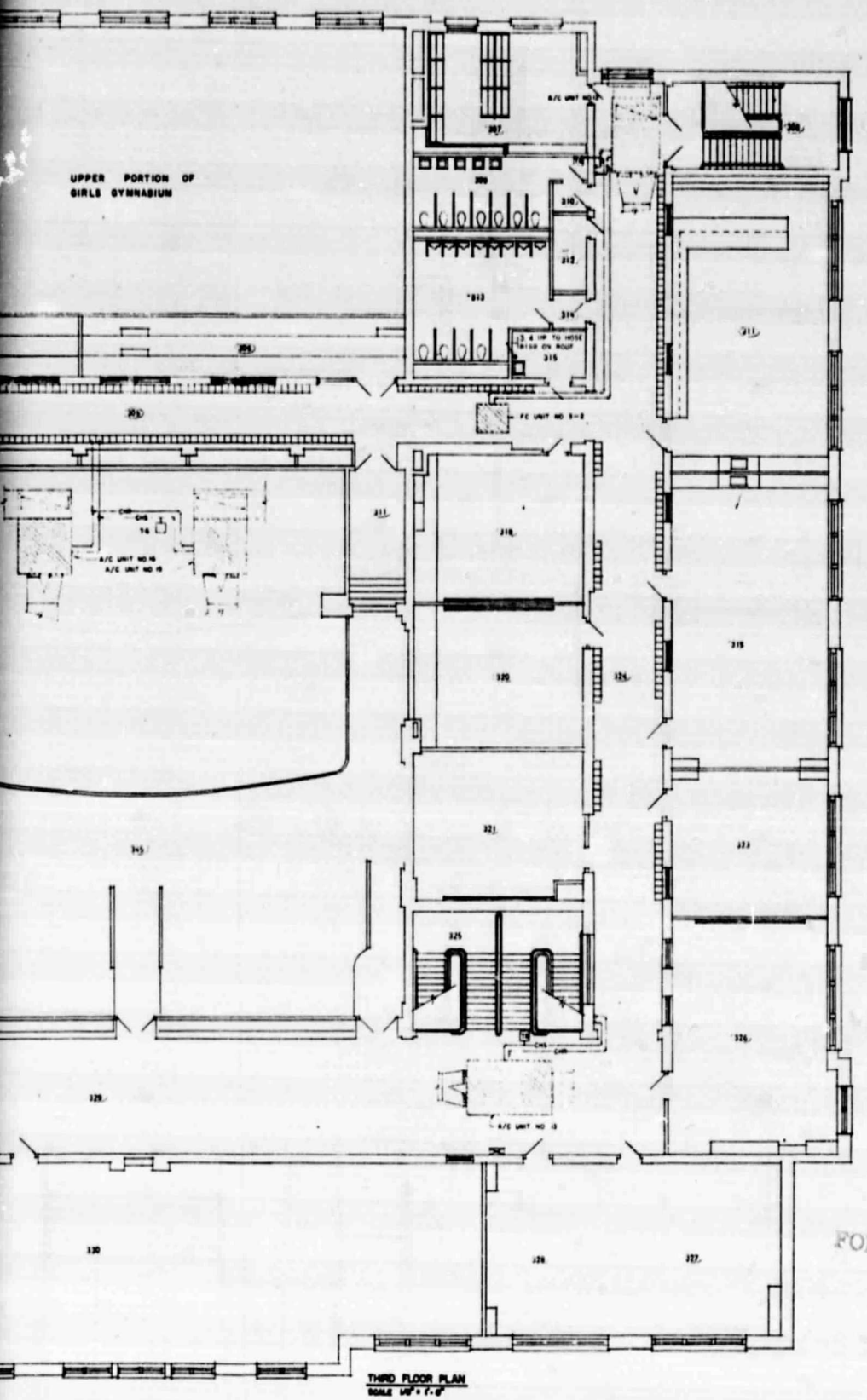
REVISIONS

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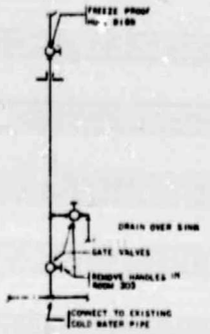
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CONSULTING ENGINEERS

CONSULTANTS

FOSTER + MEI
600 LTV TOWER



THIRD FLOOR PLAN
SCALE 1/8" = 1'-0"



PIPING CONNECTION TO HOSE BIBB ON ROOF
NO SCALE

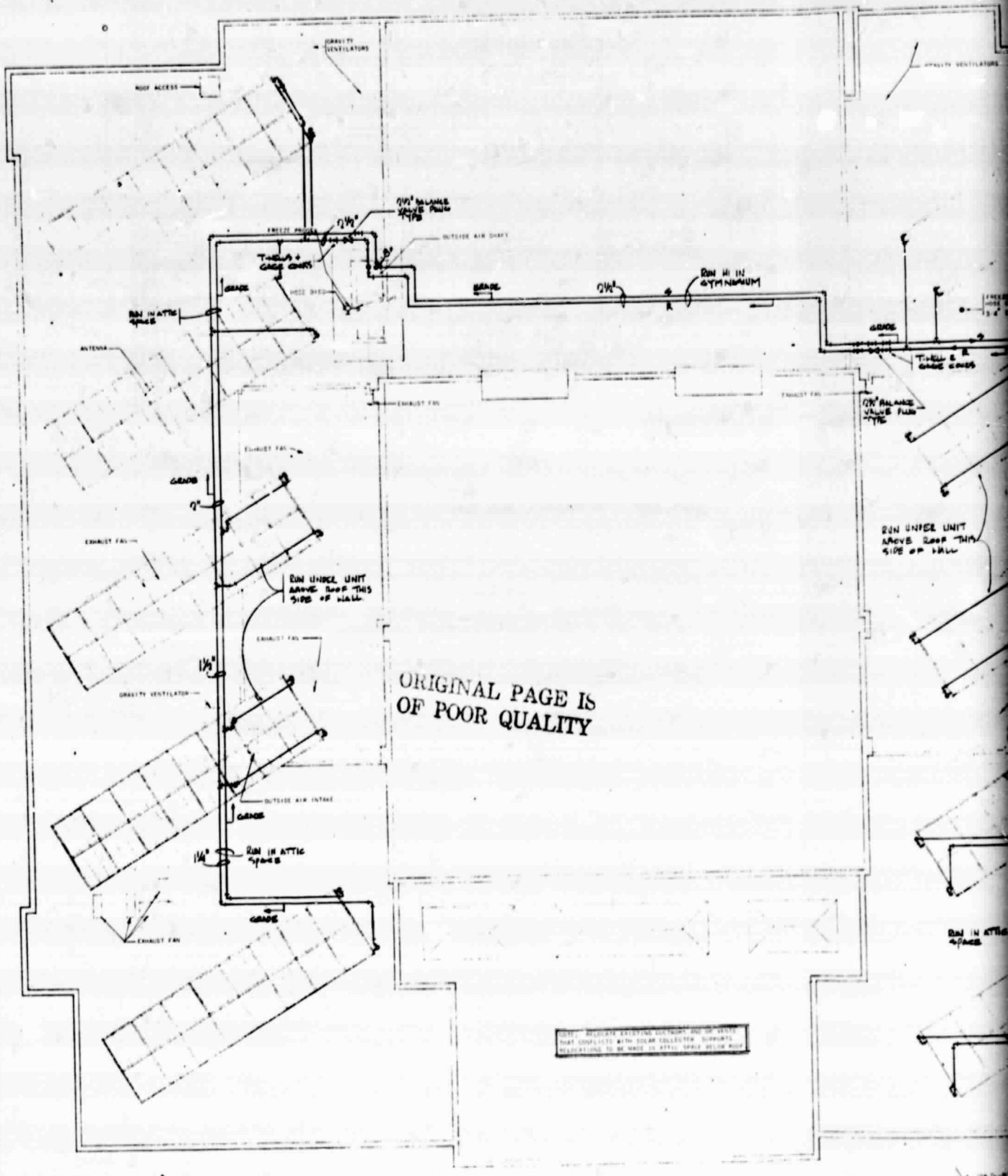
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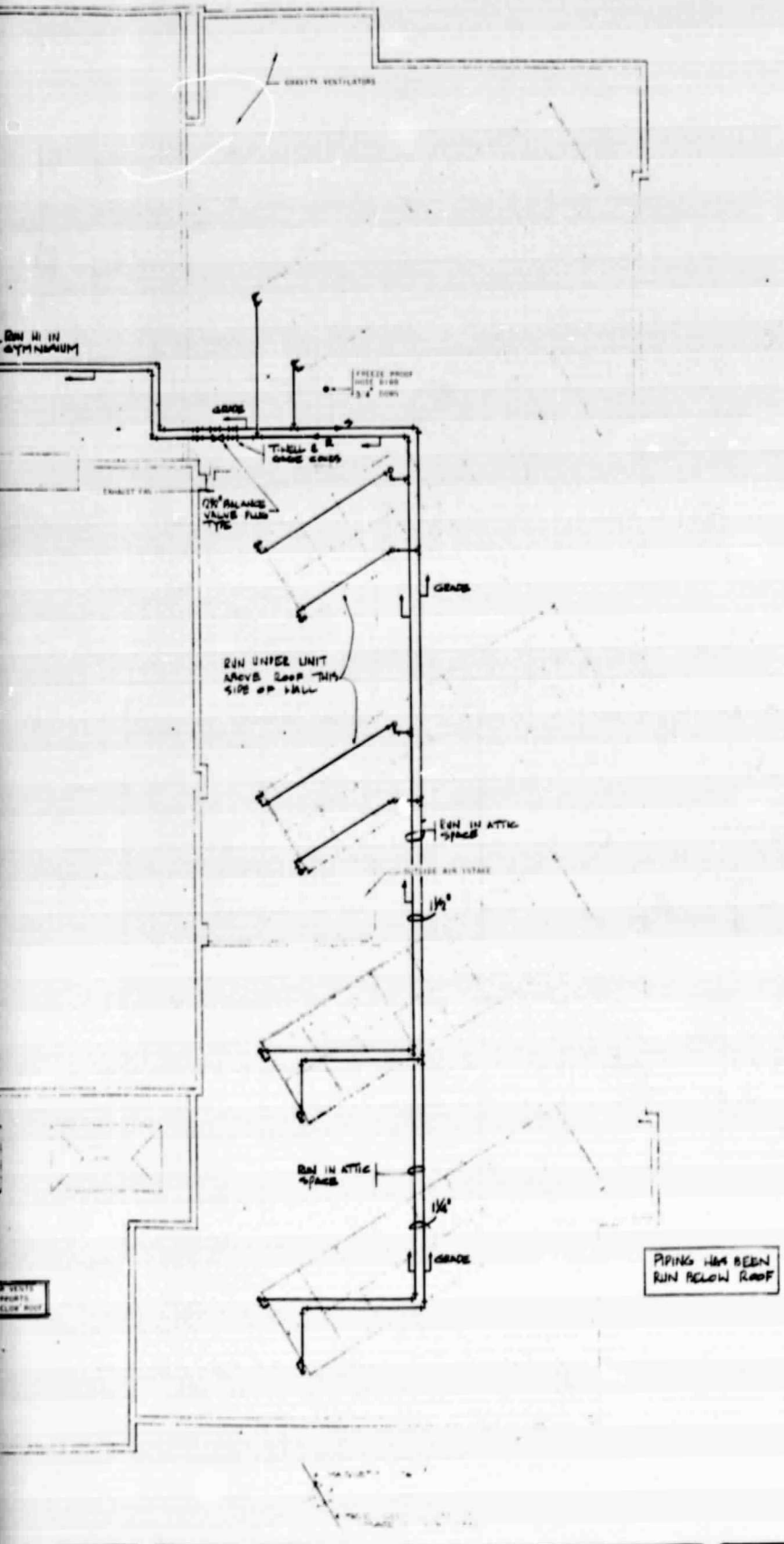
REVISIONS

JAMES L. MITCHELL, INC.
STRUCTURAL ENGINEERING CONSULTANTS

WILLIAM K. HALL & CO
CONSULTING ENGINEERS

CONSULTANTS

FOSTER



PIPING HAS BEEN RUN BELOW ROOF

FOLDOUT FRAME 2

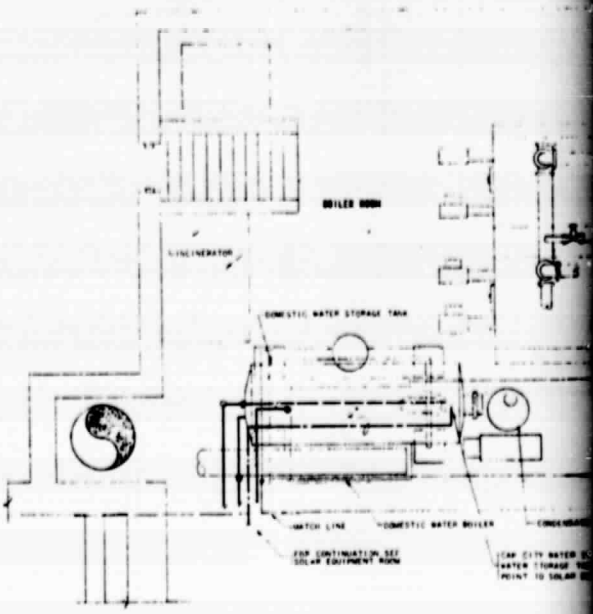
AS BUILT DRAWINGS 2/13/80

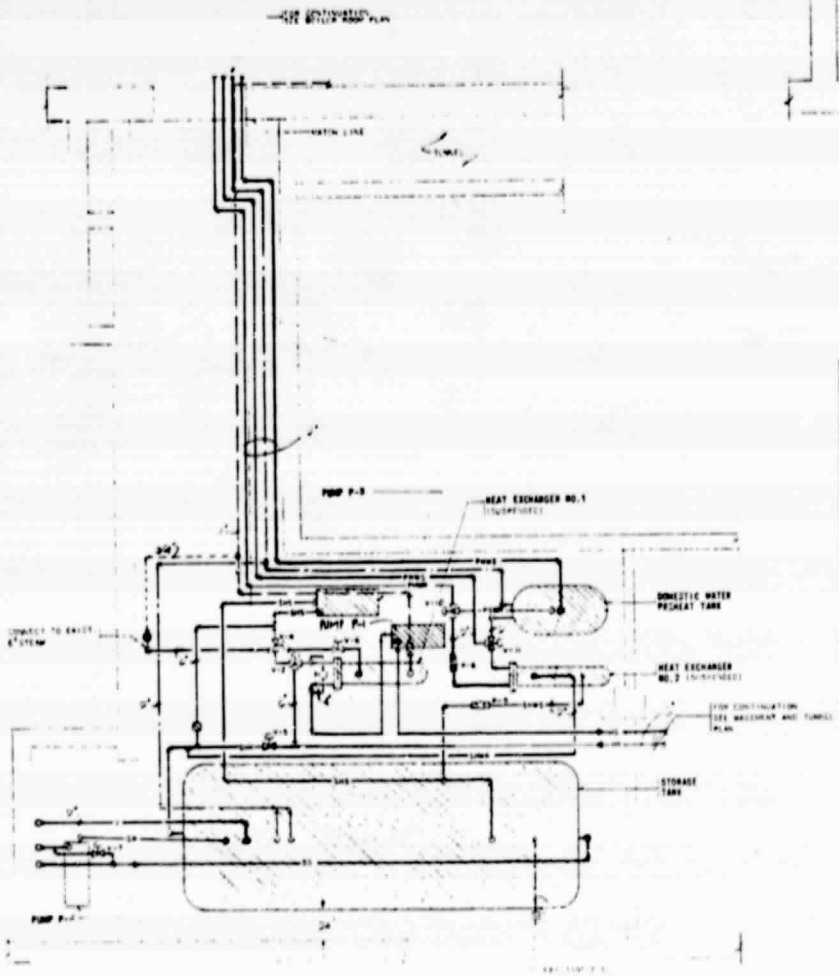
FOSTER + MEIER ARCHITECTS, INC.
800 LTV TOWER DALLAS, TEXAS 75201 214 748-5055

SOLAR MODIFICATION
OF
EXISTING BUILDING HEATING & DOMESTIC HOT WATER SYSTEMS
NORTH DALLAS HIGH SCHOOL
DALLAS INDEPENDENT SCHOOL DISTRICT

LAST ISSUE
DATE OCT 30, 1978
JOB NO. 424

SHEET NO. M-5
SEQUENCE NO.





A.H. UNIT SCHEDULE

UNIT NO.	SERVES	C.F.M.	REMARKS
1	1ST FLOOR EAST	9800	
2	1ST FLOOR SOUTH	6540	
3	1ST FLOOR WEST	6610	
4	1ST FLOOR INTERIOR	1400	
5	1ST FLOOR INTERIOR	1375	
6	CAFETERIA	4380	
7	CAFETERIA	4380	
8	BAND ROOM	2665	
9	2ND FLOOR EAST	6185	
10	2ND FLOOR SOUTH	7375	
11	2ND FLOOR WEST	5960	
12	2ND FLOOR EAST	6990	
13	2ND FLOOR SOUTH	10,750	
14	2ND FLOOR WEST	6810	
15	AUDITORIUM	10,400	
16	AUDITORIUM	10,450	
17-2-1	1ST FLOOR INTERIOR	3000	
17-2-2	2ND FLOOR INTERIOR	3530	
17-2-3	3RD FLOOR INTERIOR	3230	
17-2-4	4TH FLOOR INTERIOR	5990	
FAN COIL	TEACHERS LOUNGE	900	

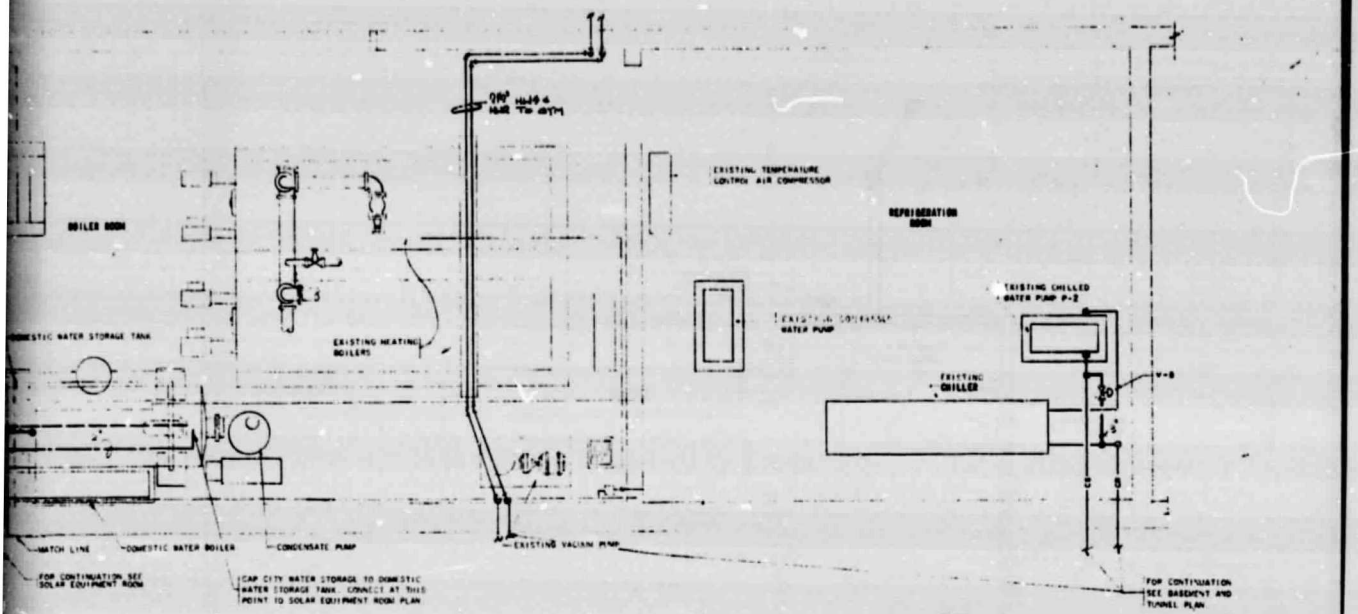
SOLAR EQUIPMENT ROOM
SCALE 1/4"=1'-0"

FOLDOUT FRAME

REVISIONS

JAMES L. MITCHELL, INC.
STRUCTURAL ENGINEERING CONSULTANTS
WILLIAM K. HALL & CO
CONSULTING ENGINEERS
CONSULTANTS

FOSTER-MEIER

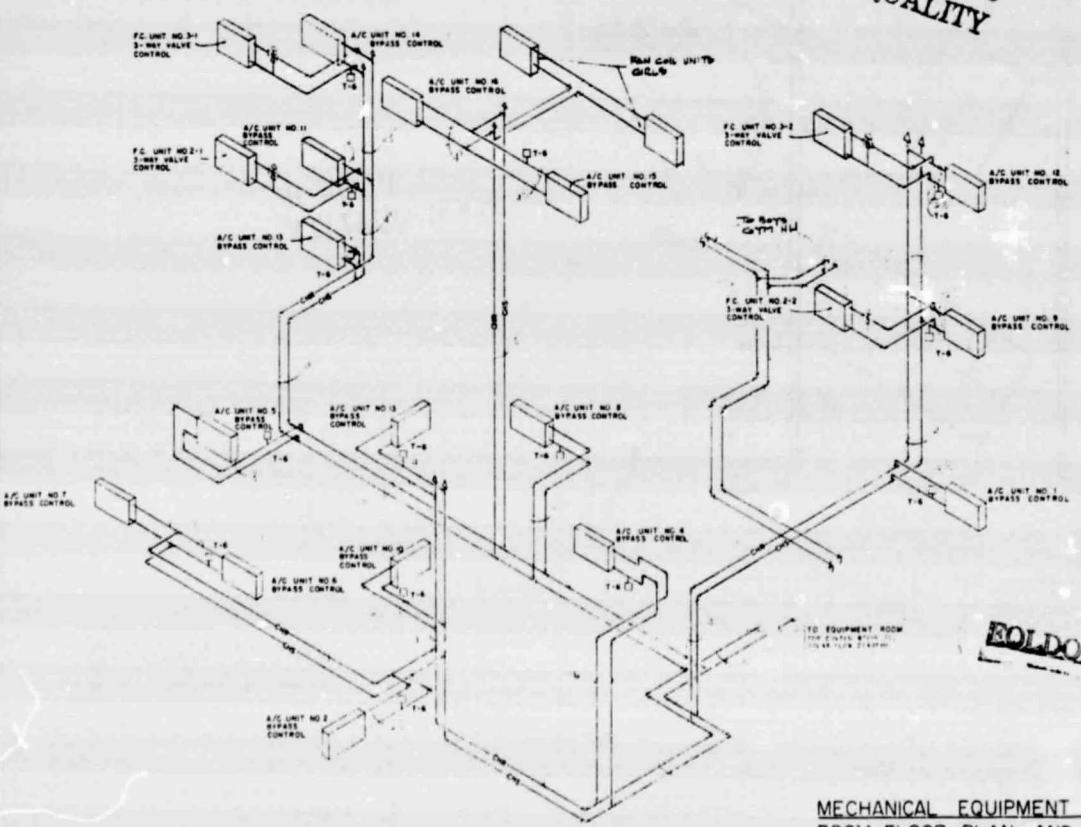


BOILER ROOM & REFRIGERATION ROOM PLAN
SCALE: 1/4"=1'-0"

ORIGINAL PAGE IS OF POOR QUALITY

SCHEDULE

	REMARKS



CHILLED WATER PIPING DIAGRAM
SCHEMATIC ONLY

FOLDOUT FRAME 2

MECHANICAL EQUIPMENT ROOM FLOOR PLAN AND CHILLED/HEATER SCHEMATIC

AS BUILT DRAWINGS 2/13/80

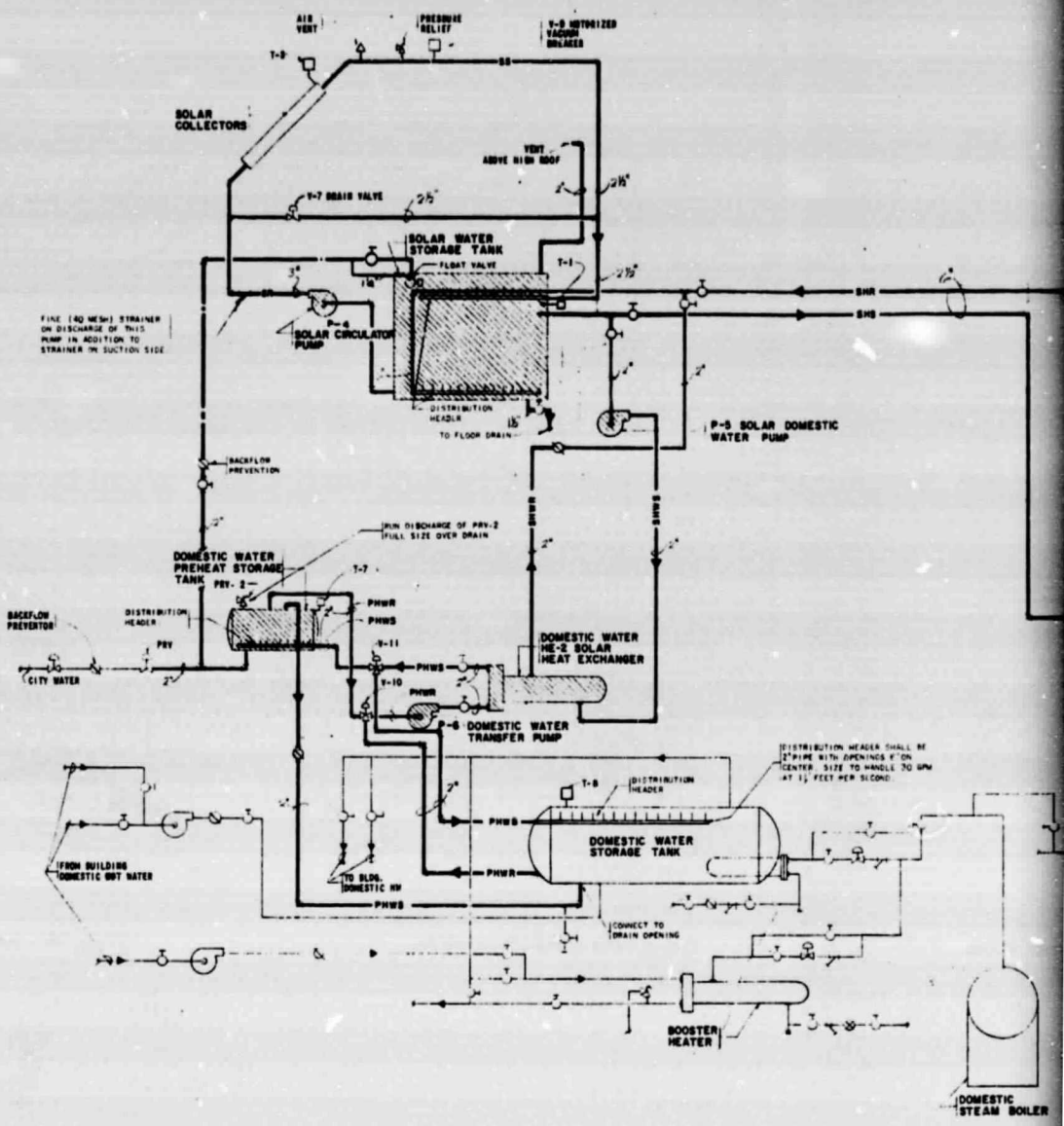
FOSTER + MEIER ARCHITECTS, INC.
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DALLAS INDEPENDENT SCHOOL DISTRICT

LAST ISSUE
DATE
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SHEET NO. M-6
SEQUENCE NO.

C-2



SOLAR FLOW DI

SCHEMATIC ONLY

FOLDOUT FRAME

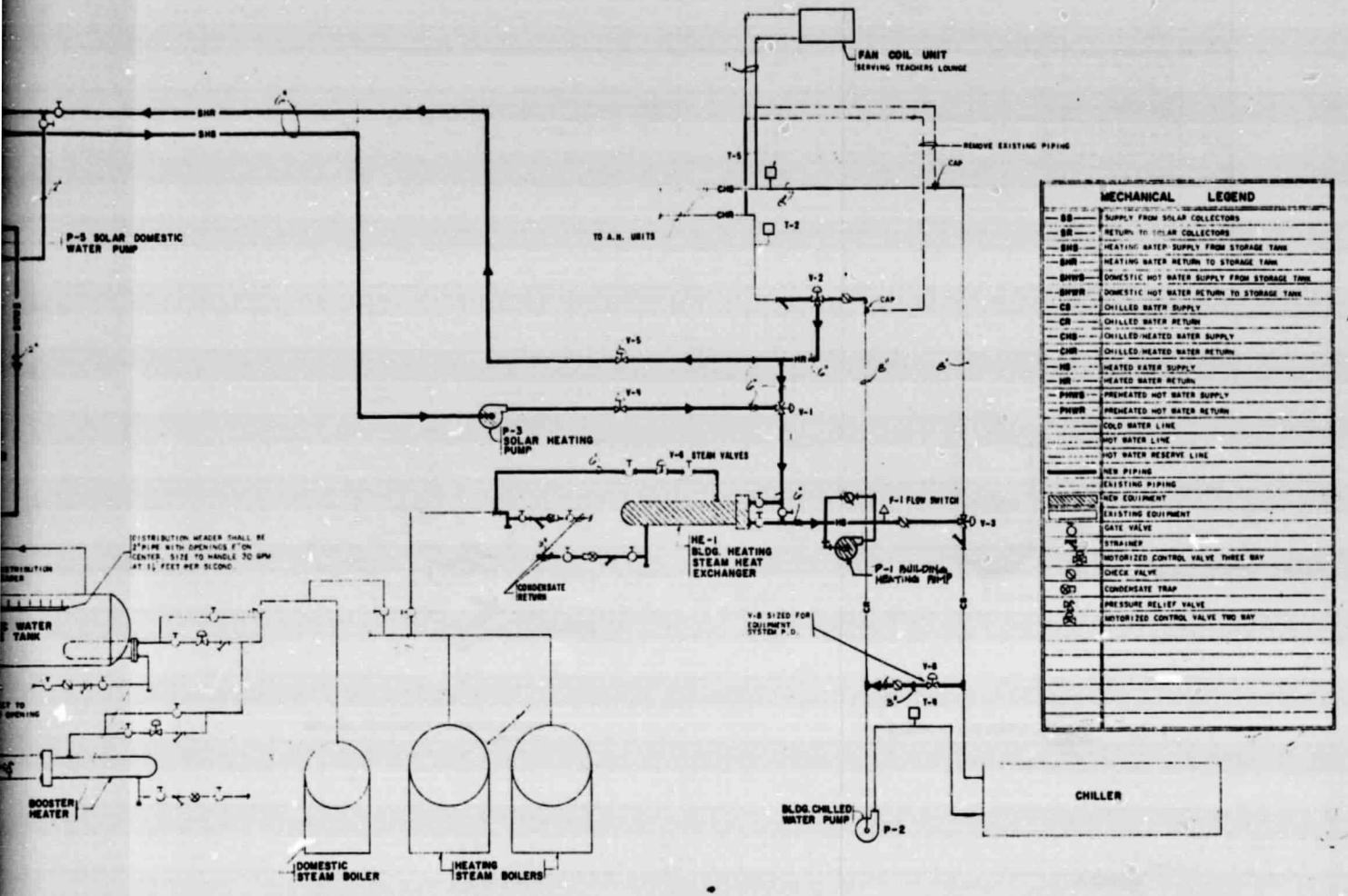
REVISIONS

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CONSULTING ENGINEERS

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FOSTER+
800 LTV TOWER



MECHANICAL LEGEND	
SS	SUPPLY FROM SOLAR COLLECTORS
SR	RETURN TO SOLAR COLLECTORS
SHS	HEATING WATER SUPPLY FROM STORAGE TANK
SHR	HEATING WATER RETURN TO STORAGE TANK
SHWS	DOMESTIC HOT WATER SUPPLY FROM STORAGE TANK
SHWR	DOMESTIC HOT WATER RETURN TO STORAGE TANK
CS	CHILLED WATER SUPPLY
CR	CHILLED WATER RETURN
CHS	CHILLED/HEATED WATER SUPPLY
CHR	CHILLED/HEATED WATER RETURN
HS	HEATED WATER SUPPLY
HR	HEATED WATER RETURN
PHWS	PREHEATED HOT WATER SUPPLY
PHWR	PREHEATED HOT WATER RETURN
	COLD WATER LINE
	HOT WATER LINE
	HOT WATER RESERVE LINE
	NEW PIPING
	EXISTING PIPING
	NEW EQUIPMENT
	EXISTING EQUIPMENT
	GATE VALVE
	STRAINER
	MOTORIZED CONTROL VALVE THREE WAY
	CHECK VALVE
	CONDENSATE TRAP
	PRESSURE RELIEF VALVE
	MOTORIZED CONTROL VALVE TWO WAY

SOLAR FLOW DIAGRAM
SCHEMATIC ONLY

FOLDOUT FRAME 2

AS BUILT DRAWINGS 2/13/80

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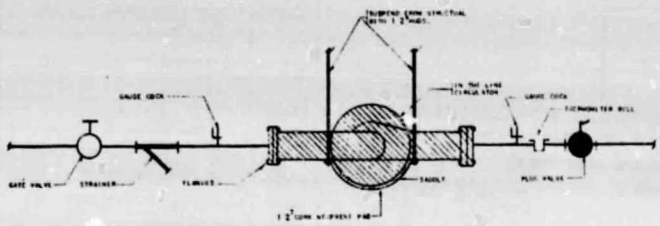
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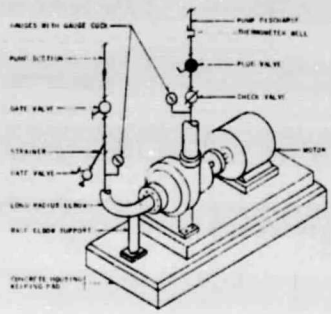
SHEET NO. M-7
SEQUENCE NO. 12

PUMP SCHEDULE

DESIG.	SERVICE	GPM	HEAD	RPM	HP	VOLTS PHASE	REMARKS
P-1	BUILDING HEATING	498	55	1750	10	208 3	SINGLE SUCTION-FLEX COUPLED
P-2	CHILLED WATER	1129	80	1750	30		EXISTING (INFORMATION ONLY)
P-3	SOLAR BUILDING HEATING	456	14	1750	3	208/3	SINGLE SUCTION-FLEX COUPLED
P-4	SOLAR COLLECTORS	80	90	1750	5	208 3	SINGLE SUCTION-FLEX COUPLED
P-5	SOLAR DOMESTIC WATER	30	17	1750	1 3	120 1	IN-THE-LINE CIRCULATOR
P-6	DOMESTIC WATER	30	17	1750	1 3	120 1	IN-THE-LINE CIRCULATOR

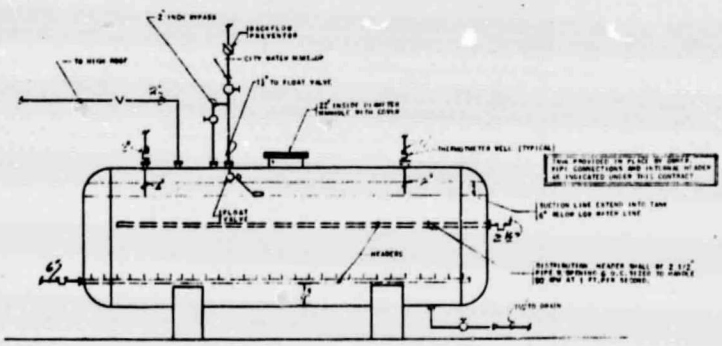


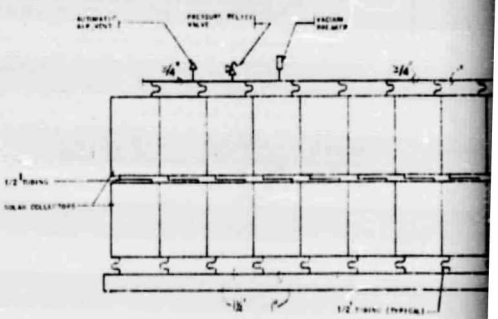
IN-LINE CIRCULATOR DETAIL
NO SCALE



PUMP PIPING CONNECTION DETAIL
NO SCALE

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OF POOR QUALITY





OLDOUT FRAME

SOLAR WATER STORAGE TANK
NO SCALE

PROVIDE NEOPRENE ISOLATION PAD AT TANK SUPPORT TO PROVIDE THERMAL BREAK AT INSULATION

TYPICAL
NO SCALE

REVISIONS

JAMES L. MITCHELL, INC.
STRUCTURAL ENGINEERING CONSULTANTS

WILLIAM K. HALL & CO
CONSULTING ENGINEERS

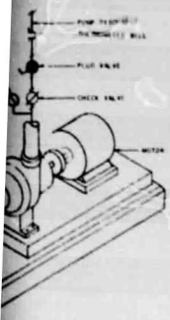
CONSULTANTS

FOSTER + M
800 LTV TOWER

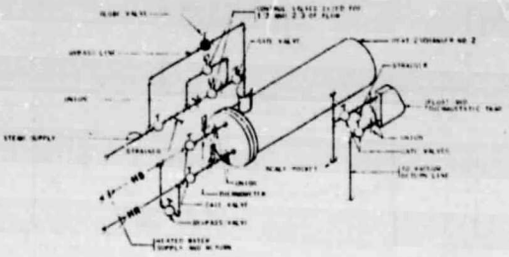
HEAT EXCHANGER SCHEDULE

DESIG.	SERVICE	CAPACITY BTUH	TYPE	SHELL GPM	SHELL ENT °F	SHELL STEAM PRESS	TUBE GPM	TUBE ENT °F	TUBE PRESS DROP	REMARKS
1	BUILDING HEATING	7,000,000	SU	—	—	5 PSI	456	85	39'	SUSPENDED FROM CLG.
2	DOMESTIC WATER	150,000	W.H.	30	170	—	30	145	11'	SUSPENDED FROM CLG.

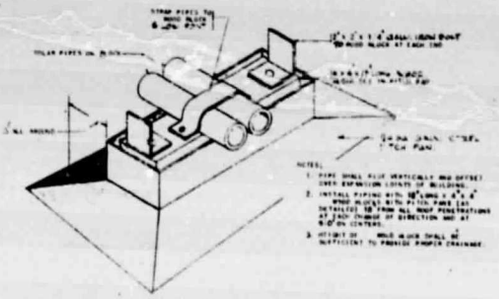
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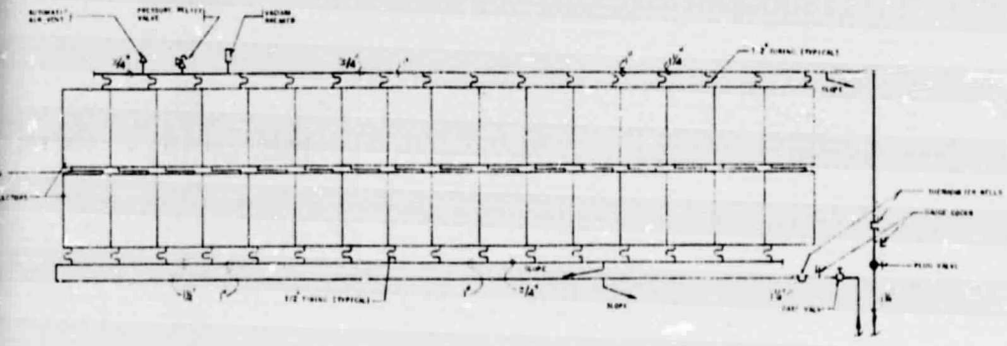
CONNECTION DETAIL



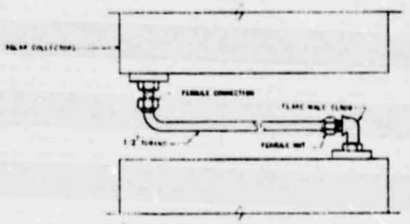
HEAT EXCHANGER NO.2 PIPING DETAIL
NO SCALE



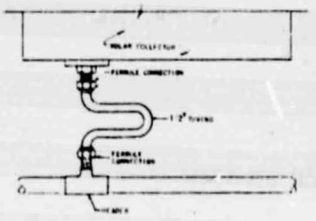
TYPICAL ROOF SOLAR PIPE SUPPORT DETAIL
NO SCALE



TYPICAL SOLAR COLLECTOR PIPING
NO SCALE



TYPICAL CONNECTION BETWEEN COLLECTORS
NO SCALE



TYPICAL CONNECTION BETWEEN HEADER & SOLAR COLLECTOR
NO SCALE

AS BUILT DRAWINGS 2/13/80

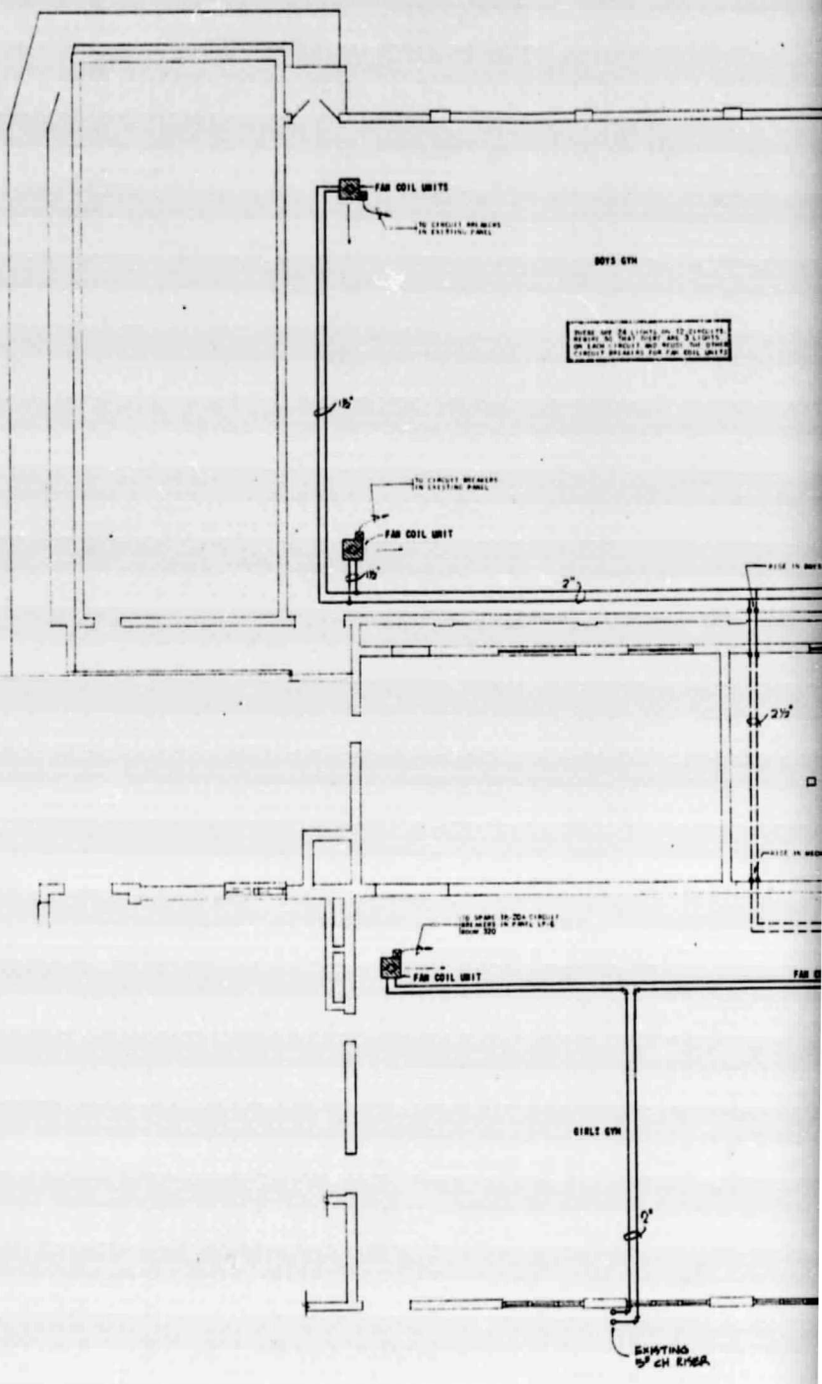
SCHEDULES & DETAIL

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800 LTV TOWER DALLAS, TEXAS 75201 214/748-5055

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COMPOSIT FLOOR PLAN
SCALE : 1/8"=1'-0"

FOLDOUT FRAME

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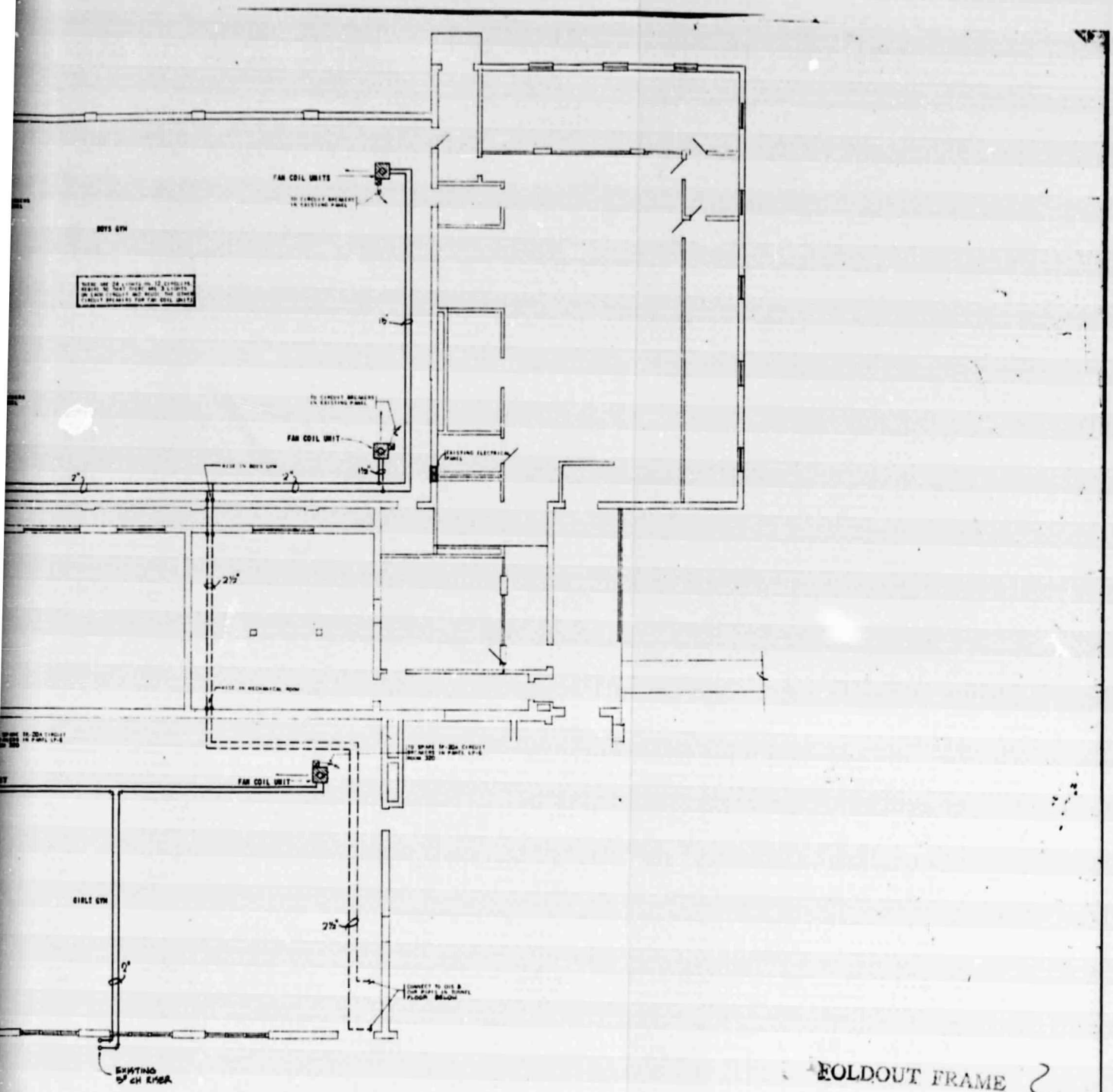
REVISIONS

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CONSULTING ENGINEERS

CONSULTANTS

FOSTER
800 LTV TOWE



FOLDOUT FRAME 2

COMPOSIT FLOOR PLAN
SCALE 1/8"=1'-0"

AS BUILT DRAWINGS 9/19/80

ALTERNATE

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SHEET NO. M-9
SEQUENCE NO. 14